Customized FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY DOCKET NO. P07179US00/RFH

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/830151

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/03528	25 October 1999	23 October 1998

TITLE OF INVENTION: METHOD AND APPARATUS FOR NEGOTIATING USING AN ELECTRONIC...

APPLICANT(S) FOR DO/EO/US: VULKAN et al.

Applicant herewith submits to the US Designated/Elected Office (DO/EO/US) the following items and other information:

X 1. This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

☐ 2. This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.

X 3. This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 371(b) and PCT Art. 22 and 39(1).

X 4. A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

X 5. A **copy** of the International Application as filed (35 U.S.C. 371 (c)(2))

- ☐ a. is transmitted herewith (required only if not transmitted by the International Bureau).
- X b. has been transmitted by the International Bureau.
- ☐ c. is not required, as the application was filed in the United States Receiving Office (RO/US).

☐ 6. A **translation** of the International Application into English (35 U.S.C. 371(c)(2)).

X 7. Amendments to the claims of the International Appln. under PCT Article 19 (35 USC 371 (c)(3))

- ☐ a. are transmitted herewith (required only if not transmitted by the International Bureau).
- ☐ b. have been transmitted by the International Bureau.
- ☐ c. have not been made; however, the time limit for making such amendments had NOT expired.
- X d. have not been made and will not be made.

☐ 8. A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

☐ 9. An **oath** or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

☐ 10. A translation of the annexes to the Int'l Prelim. Exam. Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

☐ 11. An **Information Disclosure Statement** under 37 C.F.R. 1.97 and 1.98.

☐ 12. An **Assignment** document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

☐ 13. A **First preliminary amendment.**

☐ 14. A Second or Subsequent preliminary amendment.

☐ 15. A substitute specification.

☐ 16. A change of power of attorney and/or address letter.

☐ 17. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 & 35 USC 1.821-825.

☐ 18. A second copy of the published international application under 35 USC 154(d)(4).

☐ 19. A second copy of the English translation of the international application under 35 USC 154(d)(4).

☐ 20. Other items or information:

☐

☐

☐ A copy of the Notification of Missing Requirements under 35 U.S.C. 371.

☐ In the event that a petition for extension of time is required to be submitted herewith, and in the event that a separate petition does not accompany this response, applicant hereby petitions under 37 CFR 1.136(a) for an extension of time of as many months as are required to render this submission timely. Any fee is authorized in 17(c).

Date: 23 April 2001

LARSON & TAYLOR, PLC • 1199 North Fairfax St. • Suite 900 • Alexandria, VA 22314

U.S. APPLICATION NO. (If known) 09/830151	INTERNATIONAL APPLICATION NO. PCT/GB99/03528	ATTORNEY DOCKET NO. P07179US00/RFH

		CALCULATIONS PTO USE ONLY
X	21. **The following fees are submitted:**	
X	**Basic National Fee** (37 CFR 1.492 (a) (1)-(5):	
☐	Neither Int'l Prelim. Exam. fee nor Int'l Search fee paid to USPTO $1000	
X	Search Report has been prepared by the EPO or JPO $ 860	
☐	No Int'l Prelim. Ex. fee paid to USPTO but Int'l Search fee paid to USPTO $ 710	
☐	International preliminary examination fee paid to USPTPO $ 690	
☐	Int'l Prelim. Ex. fee paid to USPTO & all claims satisfied PCT Art. 33(1)-(4) $ 100	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00
☐	Surcharge of **$130** for furnishing the oath or declaration later than ☐ 20 mos. ☐ 30 mos. + from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	*NUMBER FILED*	*NUMBER EXTRA*	*RATE*	
Total Claims	- 20 =		X **$18** =	$
Independent Claims	- 03 =		X **$80** =	$
☐ Multiple Dependent Claim(s) (if applicable)			+ **$270** =	$

	TOTAL OF ABOVE CALCULATIONS =	**$860.00**
☐	Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½. -	$
	SUBTOTAL =	$ 860.00
☐	Processing fee of **$130** for furnishing the **English translation** later than ☐ 20 mos. ☐ 30 mos. + from the earliest claimed priority date (37 CFR 1.492(f)).	$
	TOTAL NATIONAL FEE =	$ 860.00
☐	Fee for recording the enclosed **assignment** (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40** per property +	$
	TOTAL FEES ENCLOSED =	**$860.00**
	Amount to be *Refunded*	$
	Amount to be *Charged*	$

X a. A **check** in the amount of $860.00 to cover the above fees is enclosed.

☐ b. Please charge my Deposit Account No. 12-0555 in the amount of $ to cover the above fees.

☒ c. The Commissioner is hereby authorized to charge any additional fees required or credit overpayment to Deposit Account No. 12-0555.

Note: *Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.*

SEND ALL CORRESPONDENCE TO:

Ross F. Hunt, Jr.

At the address (below) of **CUSTOMER NO. 00881.**

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SIGNATURE: Douglas E. Jackson

NAME: Douglas E. Jackson

REG. NO.: 28,518

PHONE NO.: 703-739-4900

Date: 23 April 2001

#3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent

In re patent application of: VULCAN

Serial No.: 09/830,151

Filed:

For: METHOD AND APPARATUS FOR NEGOTIATING USING AN ELECTRONIC COMMUNICATION NETWORK

Examiner: Unassigned

Art Unit: Unassigned

Docket No.: P07279US00/RFH

PRELIMINARY AMENDMENT

Assistant Commissioner of Patents

Washington, D.C. 20231

SIR:

Prior to examination, please amend the above-identified application as follow:

IN THE CLAIMS

A clean version of all pending claims is provided herewith in **Attachment A**. It will be noted that claims 6-8, 13, 14, 17, 18. 23 and 24 have been amended relative to the previously provided version as shown by the marked up version thereof in **Attachment B** provided herewith.

REMARKS

The present amendment is made to eliminate multiple dependent claims and to thus eliminate the requirement for a multiple dependent claim fee.

Respectfully submitted,

Date: June 11, 2001

By: Ross F. Hunt, Jr.
Registration No.: 24082

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ATTACHMENT A

Clean Replacement/New Claims (entire set of pending claims)

Following herewith is a clean copy of the entire set of pending claims.

1. A method of regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

2. A method according to claim 1 in which the negotiating parties negotiate according to a set of rules, and said regulation includes varying the set of rules based on said one or more confidence values.

3. A method according to claim 2 in which the set of rules are varied upon said one or more confidence values indicating a high likelihood of the negotiation reaching a predetermined disadvantageous condition.

4. A method of negotiation with one or more other negotiating parties by communication using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

negotiating based on said one or more confidence values.

5. A method according to claim 4 in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to select one of a number of predetermined negotiating options.

6. (AMENDED) A method according to claim 4 in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to determine a numerical proposition which characterises an offer.

7. (AMENDED) A method according to claim 1 which includes at least once performing the additional step of re-evaluating said one or more confidence values based on observed characteristics of said negotiation.

8. (AMENDED) A method according to claim 1 comprising a step, before said step of deriving confidence values, of deriving at least some of the set of negotiating propositions based on characteristics of the negotiating environment.

9. A method according to claim 8 in which the method includes a re-evaluation step of altering the one or more hypotheses, followed by a re-derivation of confidence values for the new set of hypotheses.

10. A method according to claim 9 in which the re-evaluation step is performed upon detecting an inconsistency between the confidence values and new information, the re-evaluation eliminating the inconsistency with the new information.

11. A method according to claim 10 in which said step of altering the one or more hypotheses includes evaluating the importance of new information, and altering the hypotheses in the case that the information is evaluated to be important.

12. A method according to claim 11 in which the one or more hypotheses concern one or more of (i) characteristics of the bargaining power of one or more further negotiating parties, (ii) characteristics of agents involved in the negotiation (e.g.

based on past experience), or (iii) are based on types of goods or services which are a subject of the negotiation.

13. (AMENDED) A method according to claim 1 further including a step of normalising the confidence values.

14. (AMENDED) A method according to claim 1 in which, in addition to the one or more hypotheses, the negotiating propositions further include additional propositions which characterize the negotiation process, the additional propositions being in terms of numerical characterization variables, and the method including a step of setting the characterization variables.

15. A method of monitoring a negotiation using an electronic communication network, in which a plurality of negotiating parties negotiate regulated by a set of negotiating propositions including one or more hypotheses, the method including identifying, by comparing the actual negotiation to the negotiating propositions, a characteristic of the negotiation.

16. A method according to claim 15 in which the characteristic is a liability of the negotiation to inefficiency in time and/or revenue generated.

17. (AMENDED) A method according to claim 15 including the further step of transmitted the characteristic to one or more of the parties, to cause that party to modify its behaviour.

18. (AMENDED) A method according to claim 1 in which the parties are self-interested agents interacting using an electronic communication network.

19. A method according to claim 18 in which the agents are automatic agents.

20. A method of linking available data and expected behaviour of self-interested agents interacting using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

linking available data and expected behaviour of said agents based on said one or more confidence values.

21. An apparatus for regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses;

means for deriving for each of said one or more hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

22. An apparatus for negotiating with one or more other negotiating parties by communication using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses:

means for deriving for each of said one or more hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for electronically negotiating based on said one or more confidence values.

23. (AMENDED) An apparatus according to claim 21 which is electronically connected to the world wide web.

24. (AMENDED) A computer program product readable by a computer device for causing the computer device to perform a method according to claim 1.

ATTACHMENT B

Marked Up Replacement Claims

Following herewith is a marked up copy of each rewritten claim together with all other pending claims.

1. A method of regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

2. A method according to claim 1 in which the negotiating parties negotiate according to a set of rules, and said regulation includes varying the set of rules based on said one or more confidence values.

3. A method according to claim 2 in which the set of rules are varied upon said one or more confidence values indicating a high likelihood of the negotiation reaching a predetermined disadvantageous condition.

4. A method of negotiation with one or more other negotiating parties by communication using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

negotiating based on said one or more confidence values.

5. A method according to claim 4 in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to select one of a number of predetermined negotiating options.

6. (AMENDED) A method according to claim 4 ~~or claim 5~~ in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to determine a numerical proposition which characterises an offer.

7. (AMENDED) A method according to ~~any preceding~~ claim 1 which includes at least once performing the additional step of re-evaluating said one or more confidence values based on observed characteristics of said negotiation.

8. (AMENDED) A method according to ~~any preceding~~ claim 1 comprising a step, before said step of deriving confidence values, of deriving at least some of the set of negotiating propositions based on characteristics of the negotiating environment.

9. A method according to claim 8 in which the method includes a re-evaluation step of altering the one or more hypotheses, followed by a re-derivation of confidence values for the new set of hypotheses.

10. A method according to claim 9 in which the re-evaluation step is performed upon detecting an inconsistency between the confidence values

and new information, the re-evaluation eliminating the inconsistency with the new information.

11. A method according to claim 10 in which said step of altering the one or more hypotheses includes evaluating the importance of new information, and altering the hypotheses in the case that the information is evaluated to be important.

12. A method according to claim 11 in which the one or more hypotheses concern one or more of (i) characteristics of the bargaining power of one or more further negotiating parties, (ii) characteristics of agents involved in the negotiation (e.g. based on past experience), or (iii) are based on types of goods or services which are a subject of the negotiation.

13. (AMENDED) A method according to ~~any preceding~~ claim 1 further including a step of normalising the confidence values.

14. (AMENDED) A method according to ~~any preceding~~ claim 1 in which, in addition to the one or more hypotheses, the negotiating propositions further include additional propositions which characterize the negotiation process, the additional propositions being in terms of numerical characterization variables, and the method including a step of setting the characterization variables.

15. A method of monitoring a negotiation using an electronic communication network, in which a plurality of negotiating parties negotiate regulated by a set of negotiating propositions including one or more hypotheses, the method including identifying, by comparing the actual negotiation to the negotiating propositions, a characteristic of the negotiation.

16. A method according to claim 15 in which the characteristic is a liability of the negotiation to inefficiency in time and/or revenue generated.

17. (AMENDED) A method according to claim 15 ~~or claim 16~~ including the further step of transmitted the characteristic to one or more of the parties, to cause that party to modify its behaviour.

18. (AMENDED) A method according to ~~any preceding~~ claim 1 in which the parties are self-interested agents interacting using an electronic communication network.

19. A method according to claim 18 in which the agents are automatic agents.

20. A method of linking available data and expected behaviour of self-interested agents interacting using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

linking available data and expected behaviour of said agents based on said one or more confidence values.

21. An apparatus for regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses;

means for deriving for each of said one or more hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

22. An apparatus for negotiating with one or more other negotiating parties by communication using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses:

means for deriving for each of said one or more hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for electronically negotiating based on said one or more confidence values.

23. (AMENDED) An apparatus according to claim 21 ~~or claim 22~~ which is electronically connected to the world wide web.

24. (AMENDED) A computer program product readable by a computer device for causing the computer device to perform a method according to ~~any of claims 1 to 20~~ claim 1.

marked claims

METHOD AND APPARATUS FOR NEGOTIATING USING AN ELECTRONIC COMMUNICATION NETWORK

Field of the invention

The present invention relates to methods and apparatuses for trading using an electronic communication network. It further relates to computer program products carrying software for performing the methods.

Background of the invention

The phenomenal growth of the Internet and worldwide web in this last decade has been the driving force behind growth of electronic based trade and an explosion in electronic commerce (e-commerce) applications. Electronic commerce can be loosely defined as the process of trade which takes place through computer mediated electronic communication networks. Such systems can be further classified as "first generation" e-commerce systems, which are user-driven systems in which each user retains control of all trade related decisions, and "second generation" e-systems, in which each user delegates authority over some trade related decisions to an automatic agent (defined in software). Software agents interact using a "protocol", to further their users' interests.

e-commerce is only one example of a negotiation between self interested entities (human or software) which is carried out through computer mediated networks.

Second generation e-commerce systems are a special case of multi-agent systems (MAS). Multi-agent systems can interact (once a protocol has been agreed) in an automated fashion. The use of multi-agent systems is known in the fields of industry, entertainment, patient care, health planning and finance, and such systems are described, for example, in the article "Applications of Intelligent Agents" by N.R. Jennings and M. Wooldridge (1997), available under electronic reference http:///www.springer.de/comp/special/jennings.pdf.

The principal feature of the agents is to be "self-interested", that is each of the agents acts in a way which maximises its (or its users') goals. For example, considering a commercial transaction in which a customer wishes to place a long-distance telephone call, the customer may employ a self-interested agent which interacts with various telephone providers (other agents) to obtain the cheapest telephone supply.

Furthermore, the Internet is emerging as the most efficient medium for carrying out business-to-business transactions, because it offers easy access to a large number of potential sellers and to their catalogues. The industry is also moving towards growing standardisation of communication infrastructures over which different organisations can interact and safely carry out transactions, hence reducing the costs of communicating and doing business electronically.

With the increasing spread of the Internet, more and more commercial transactions are taking place electronically. Consumers purchase books and CDs, and businesses conduct electronic auctions of supply contracts. Electronic double auctions, such as Fastparts (http://www.fastparts.com/), allow buyers and sellers to negotiate with each other. Some goods, such as software, can also be delivered via the net. The Internet, particularly the World Wide Web, is emerging as one of the most efficient media for carrying out business-to-consumer and business-to-business transactions. The competitiveness of the Internet is likely to further increase: *Agent technology* could become for e-commerce what Windows was for PCs - a relatively simple and user-friendly way of using the new technology. In this framework individuals and organisation interact via the network using *software agents*. A software agent (also *automated*, or *autonomous* agent) is a program that acts independently on behalf of its user and in of its interests. The main characteristic of these interactions is that the user *delegates* the authority to search, match, and even to transact business to the agent.

An example of an interesting recent development in electronic commerce is the buying and selling electronically of the right to transmit data over the net and the telecommunications infrastructure. Organisations like Band-X (http://www.band-x.com/), RateXchange

(http://www.ratexchange.com/) and Min-X (http://pulver.com/min-x/) provide bulletin boards and double auctions to buy and sell bandwidth and connection time. Currently, these transactions are wholesale, between large operators. However, we could imagine such transactions taking place far more frequently. If negotiation were cheap and easy, and appropriate billing infrastructure was in place, re-negotiation of connection contracts could take place every few seconds. This would allow sources of traffic (such as local Internet service providers) to dynamically switch between long distance carriers in response to price fluctuations. In this way, a spot market for bandwidths could develop.

One of the keys to making this happen is the ability to negotiate automatically. If negotiations are to take place constantly it would be expensive for people to perform the task. Furthermore, they will not always be able to react fast enough to changes in market conditions. For this reason, communications bandwidth has inspired work on automated negotiation from its inception.

Summary of the invention

The present invention seeks to provide new and useful methods and apparatuses for negotiating (e.g. trading) using an electronic communication network, and controlling an electronic communication network to

facilitate negotiation.

In particular it may provide a method of linking available data and expected behaviour of self-interested agents interacting using an electronic communication network.

In general terms, the invention proposes automatically forming hypotheses about the negotiating environment, with a numerical confidence level for the hypotheses (for example the confidence levels can be generated from observed negotiating behaviour and/or outcomes), and negotiating or controlling negotiation based on the confidence levels.

This formation of hypotheses may for example be by a system which is external to the negotiating parties and controls the protocol within which they negotiate (for example, to avoid unwanted behaviour of the collective system, such as the vulnerabilities described below). Alternatively, the hypotheses may be used by one (or more) party to select its own negotiating strategy (i.e. self-regulation) to obtain behaviour which is maximally beneficial to that party (or those parties).

Thus, in a first aspect, the invention in general terms proposes that the hypotheses are used to regulate the way in which two or more other parties are permitted to interact.

Specifically, the first aspect of the method is a method of regulating negotiation between two or more

negotiating parties which communicate using an electronic communication network, the method employing a set of propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and including the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

For example, the negotiating parties may negotiate according to a set of rules, and the regulation may include varying the set of rules based on said one or more confidence values. This could either be a major variation (e.g. fundamentally altering the type of auction occurring), or a minor one (such as adjusting the increment in successive bids of an auction).

In a second aspect, the invention in general terms proposes that one or more negotiating parties employ the hypotheses to influence (regulate) their own trading behaviour.

Specifically, in a second aspect the invention proposes a method of negotiation with one or more other negotiating parties by communication using an electronic communication network, the method employing a set of

negotiating propositions including one or more hypotheses concerning a negotiating environment, and including the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

negotiating based on said one or more confidence values.

The step of negotiating based on said one or more confidence values may comprise using the one or more confidence values to select one of a number of predetermined negotiating options. For example, it may include deciding whether of not to participate in the negotiation at all; which other participants to negotiate with (i.e. make an offer to); or which of a predetermined number of types of offer to make (e.g. an auction bid, a fixed price bid, or a request to another party to generate a bid itself).

Alternatively or additionally, the step of negotiating based on the one or more confidence values may comprise using the one or more confidence values to determine a numerical proposition which characterises an offer, e.g. a bid value may be calculated as a predetermined function of one or more confidence values.

We will now describe preferable details of the generation and updating of the hypotheses and confidence

values which are relevant to both aspects of the invention.

Preferably, the method includes at least once performing the additional step of re-evaluating said one or more confidence values based on observed characteristics of said negotiation.

Preferably, the method includes a step (e.g. off-line before the on-line negotiation) of deriving the set of negotiating propositions in a way appropriate to the negotiating environment. This may include selecting the one or more hypotheses, to which confidence values are then assigned.

Preferably, in addition to re-evaluation of the confidence value(s), the method includes a step (for example carried out in predefined circumstances) of re-evaluating the set of hypotheses itself, followed by a redefinition of confidence values for the new set of hypotheses. Thus, for example, if during the negotiating method the user of the method discovers an inconsistency between the confidence values and some new piece of information, the method may include re-evaluating the set of hypotheses to overcome the inconsistency.

The negotiating propositions represent a classification based on underlying strategic form, or the rules of the game. In non-automatic negotiations failure to behave in a way which is consistent with these rules can be easily pointed out to the negotiating parties.

strategy. The present invention permits a technology which allows the same for automated negotiations. For example, a party may identify propositions (either among the negotiating propositions, or derived from them), which are expected to reach constant values during negotiation. If this is not achieved, the method detects the fact, and the party using the method can identify that the hypotheses are incorrect.

Usually (though not necessarily), the re-evaluation of the set of hypotheses will increase the number of hypotheses, but the method still preferably minimises the number of hypotheses in relation to the available data.

The hypothesis setting is preferably based on economic understanding of the relevant interactions. Specifically, the set of hypotheses is based on the mathematical representation of the underlying strategic structure of the interactions. Similarly, the updating is preferably based only on data which is relevant to the economic efficiency of these interactions.

Preferably, the one or more hypotheses concern one or more of (i) characteristics of the bargaining power of one or more further negotiating parties and (ii) characteristics of agents involved in the negotiation (e.g. based on past experience). If applicable, the hypotheses are also preferably defined based on types of goods or services being traded.

Preferably, the method further including a step of

normalising the confidence values. For example, in the case that the hypotheses are mutually contradictory, the normalising step may include adjusting them so that their total value adds up to 1.

The hypotheses may fall into a number of groups. For example, one group of hypotheses may relate to the total number of negotiating parties (e.g. a first hypothesis that there is one other negotiating party, a second hypothesis that there are two, and a third hypothesis that there are more than two), while a second group of hypotheses may relate to the average size of other negotiating parties. In this case, a normalization step may involve normalizing the confidence values of the hypotheses of one or more of these groups.

In addition to the hypotheses, the negotiating propositions may further include additional propositions which characterize the negotiation process. For example, one such additional proposition may be whether the method is used for buying or for selling. The additional propositions may be in terms of numerical characterization variables. In this case, the method may include a step of setting the characterization variables (e.g. in the case of a selling process, the method may include a step of setting a characterization variable which represents the fact that method is selling, to "1"). The additional propositions themselves may optionally be changed, if a party fundamentally

reassesses the negotiating environment.

If a low-efficiency condition is identified, the method may include alerting one or more of the users to this fact, and preferably triggering a re-evaluation of the hypotheses and/or confidence values.

Accordingly, in a third aspect, the invention provides a method of monitoring a negotiation using an electronic communication network, in which a plurality of negotiating parties negotiate regulated by a set of negotiating propositions including one or more hypotheses, the method including identifying, by comparing the actual negotiation to the negotiating propositions, a characteristic of the negotiation.

For example, the characteristic may by the liability of the negotiation to inefficiency (in time and/or revenue generated). This information may be transmitted to one or more of the parties, to cause them to modify their behaviour. Alternatively or additionally, as explained above, it may be used to modify a protocol which determines the rules within which the parties interact.

In any of the aspects, the negotiating environment may be any situation in which more than one party negotiates, such as a commercial situation in which one or more suppliers trade to supply one or more goods or services to one of more buyers (e-commerce). It also includes negotiations which are not specifically

concerning the supply of goods or services, such as a negotiation concerning timings for a meeting.

Advantageous effects obtainable by the invention

An example of the usefulness of the invention in its first aspect is for multi-agent systems composed of or including self interested agents are vulnerable, in the sense that problems may arise which significantly reduce the efficiency of the trading.

Four examples of such vulnerability will now be given.

Firstly, consider an agent which represents a customer which wishes to buy a good. If the agent insists on obtaining a low price for the goods (because it is programmed to do so) but communicates only with selling agents which are not allowed to negotiate prices, an impasse will be reached. The fruitless communications between the customer's agents and the selling agents use up network resources, and can thus significantly reduce the overall efficiency of the trading environment.

Secondly, consider the case of two agents programmed to schedule a meeting between their respective users. If the two users have conflicting requirements concerning the time or place of the meeting, then a negotiation between the scheduling agents will be fruitless. If neither agent is willing to make a concession, then an impasse is reached, and the

communication has consumed network resources to no purpose.

Thirdly, consider an on-line auction. In this case, the efficiency of the trading is determined, among other factors, by the revenue which is generated for the sellers. A variety of protocol types can be identified, such as so called "English auctions" or "first-price sealed-bid" auctions. The revenue generated generally depends on the type of protocol, but which protocol type maximises efficiency can depend on the characteristics of the auction (for example on whether the goods being sold can be re-sold). If the sellers and buyers have a mis-matched understanding of this underlying structure, then the auction is unlikely to be efficient.

Fourthly, consider a market for goods such as electronic components. Conventionally in such a market both sellers and buyers post prices and trade takes place when those prices match. What constitutes optimal behaviour for the trading agents depends on the ratio between the quantity of goods demanded and the quantity supplied. Specifically, if only one agent is selling a certain component and many agents demand that component, then the seller can expect to extract much of the surplus for itself. On the other hand, if supply greatly exceeds demand, the buyer should be able to extract most of the surplus. Thus, if the agents of the sellers and buyers are not sensitive to the ratio of supply and demand,

their expectations may mis-match and impasses of the kind described above may occur.

In a multi-agent systems, as opposed to other distributed computer systems, there is no control over the behaviour of individual agents, except through the protocol. Currently because of the risk of inefficiencies, these systems maintain the option of intervening and dictating agreements. This is highly undesirable (since it goes against the main motivation for using MAS). Also, in the long run agents can learn to anticipate that the system will intervene, and change their behaviour accordingly, causing even more inefficiency. For example, a party which believes it will be better off if the system intervenes will deliberately make negotiations inefficient to ensure intervention by the system.

In the first aspect as defined above, the invention may attempt to reduce the vulnerability of a multi-agent system. The method may be carried out, for example, to influence the protocol, or even as part of the protocol.

As for the second aspect of the invention, for agents to be fully autonomous, they must be able to learn and adjust to changing circumstances. Agents will choose their bids on-line based on current information from the user (e.g. maximal willingness to pay, priority of achieving trade) and on past observations. For example, an agent selling bandwidth is required to strike a

balance between submitting a high asking price (to increase profits), and insuring a high probability of reaching deal (by not asking for a price which is too high). The current invention can be used by agents trading in automatic markets for bandwidth, providing them with on-line information regarding the underlying strategic structure of these interactions, hence allowing them to choose their asking price optimally.

The invention can be used for other types of business-to-business interactions. To see how, notice that Internet-based commerce may come very close to Adam Smith's vision of free markets where an "invisible hand" co-ordinates prices so as to equate supply and demand of all goods and services. For markets to become competitive, according to Smith's vision, prices must be flexible enough so that supply and demand can adjust to each other and to changing circumstances. In light of this it is not surprising that on-line auctions are emerging as an important feature of e-markets: Sellers of goods and services are favouring using auctions to offering fix-price tariffs. Auction provides for sellers an efficient method of offering a fully flexible price without the disadvantages associated with price haggling and direct negotiations. Moreover, it allows sellers to "play" potential buyers against one another hence, in many cases, maximising sellers' potential profits. Double auctions (where sellers and buyers both post

prices) are also used in some cases, but the bulk of the trade is carried out using one-sided auctions which empower only the seller.

Given the background, buyers now require the appropriate technology to empower *them* in response to these changes. New issues now arise, which are not supported by existing Automated Procurement (AP) Systems, or Manufacturing Resource Planning (MRP) systems. What, for example, should the buyer do if not all required quantity can be obtained from one source? What if what's on offer satisfies only some of the buyer's requirements (for example, it may be cheap, but the quality and after-sales services may not be as good as that of another, more expensive, seller)? How should the buyer bid if she participates in *several* on-line auctions?

These issues are significant even if the number of potential suppliers is relatively small: If not all prices are fixed, then the organisation will require IT which integrates existing applications (e.g. AP and MRP systems) with a strategic reasoner based on an economic understanding of the market. By integrating the procurement system, the search & match, and seller negotiations, with the strategic reasoner, it becomes possible to effectively address questions like who to buy from and how much, how to bid in an auction, given the current best available fixed price, and so on.

The current invention can be used by corporate

buyers as the basis for making strategic choices regarding: Who to buy from? How much to buy from each of these sellers? And, should the organisation try to negotiate a better deal, and if so how?

The invention provides vital information to the purchaser. Moreover, the type of strategic considerations considered by the invention is otherwise very hard to obtain. We now explain why a strategic classification is so important for corporate buyers faced with a number of dynamic market mechanisms (i.e. mechanisms where the price is not fixed, like auctions).

In a fixed pricing world, sellers set prices, and trade with buyers who value the goods at more than the asking price. Prices are then determined by sellers' costs and by competition from other sellers. In a world of no fixed prices, everything is negotiable. In general who pays what will depend on the bargaining powers of the negotiating parties. By carrying out an auction, the seller is able to abstract from direct negotiations, and gain most of the "negotiations surplus" to itself, by playing potential buyers against one another. Unlike business-to-consumers auctions (like eBay.com), where collectables are traded, sometimes at what seems like bargain prices, business-to-business auctions are carried out solely to increase the revenues of sellers.

Decision making in such dynamic environment is extremely ***complex***. Purchasing decisions are hard enough

in a stable environment with a fixed number of approved vendors, and with fixed pricing. In an open environment with sem-dynamic pricing, purchasing decisions are simply too complex to be handled without IT support. To illustrate this point consider the example of an organisation which normally buy from the cheapest amongst its of 5 approved vendors. Using the Web, the organisation identifies 5 more potential sellers. Since there are no fixed prices, the purchaser will need to consider combination like "buy X units from A, Y units from B, and the rest from C". With 10 sellers there are $2^{10} = 1024$ combinations, or subsets, of sellers to consider. But since the purchaser needs to decide what quantity to buy from each seller, it is easy to see that 1024 is in fact a very conservative estimate for the number of alternatives to be considered.

Another considerations which complicated purchasing decisions are:

- **Action-Reaction:** The outcome of a decision to buy from A rather than B, will depend on how A and B react. For example, it will not be wise to lose the "valued customer" status, for a small, one-off discount. Similarly, how much to bid in an auction will normally depend on how much the other buyers are likely to bid. These types of speculations can considerably increase the complexity of making

buying decisions.

- **Multi-attributes:** Most business-to-business transactions depend not only on price, but also on other attributes like quantities available, quality assurances, guaranteed time to delivery, after-sale support and so on. Each option of where and how much to buy will need to be evaluated using a multi-dimensional scale which weigh the various relevant attributes according to the organisation preferences. Once more, this increases the complexity of the decision rule.

Complexity can explain much of the ***rigidity*** (or ***friction***) commonly observed in business-to-business trading. Organisations tend to continue buying from the same suppliers because it is too costly and difficult to continuously engage in new search and match or in re-negotiation. But this is normally bad for the organisation: Every time the approved sellers cannot match current needs, organisations end up buying off-contract, losing out on volume discounts, pre-negotiation agreements and so on (these off-contracts purchases are known in the industry as "maverick purchasing"). From the $1.4 trillion spent annually on MRO purchases in the US (according to *Purchasing Magazine*), an estimated 40% is purchased off-contract!

The invention can be set-up by a corporate buyer to

control purchasing decisions in its specific market (for example buying manufacturing materials). Once set-up, the invention automatically updates relevant changes to the market, and can be used to give on-line economic advice to the organisation, recommending buying strategies. This can significantly reduce the inefficiencies described above.

The negotiation may employ both the first and second aspects of the invention. That is, an automatic regulation of the overall negotiation (e.g. via the protocol) by an operator of the negotiation (e.g. the "central" operator of the web site at which the negotiation is occurring), and an automatic self-regulation of the negotiating strategy of one or more parties. Optionally, one or more of the parties may share reasoning (generating of the propositions and the confidence values) with each other, or with the "central" operator.

The invention is suitable in the case that the negotiating parties are all linked to a web, such as the world wide web, and that the electronic communication is via this web.

In further aspects, the invention provides apparatus for performing the methods of the invention. Such an apparatus may be adapted to perform a method having any of the optional features described above in relation to the first and second aspects of the

invention.

In a further aspect, the invention provides a computer program product, such as a computer-readable electronic data carrier, carrying a program for performing any of the methods described above.

Non-limiting examples of the invention will now be described for the sake of illustration.

Brief Description of the Figures

Fig.1 is a schematic diagram of a first embodiment of the invention in which a protocol of the interactions of a plurality of agents is regulated;

Fig. 2 shows the system of Fig. 1 as connected hardware units;

Fig. 3 shows an application of the system of Fig. 1 in relation to an auction;

Fig. 4 is a flow diagram in an embodiment of the invention;

Fig. 5 is an example of the logical stages in an embodiment of the invention;

Fig. 6 shows an embodiment of the invention in which a single trader uses a reasoning device to regulate its own trading behaviour; and

Fig. 7 represents the flow of information in the diagram of Fig. 6, as the invention is used by a single corporate buyer.

Description of the Preferred Embodiments

The first four examples of the invention relate to the embodiment of the first aspect of the invention shown in Fig. 1. A plurality of agents (labelled 1,..,N) interact via a protocol 5. The protocol is determined, or at least influenced, by numerical outputs of the reasoning system 7. The operation of the reasoning system 7 will now by described.

Fig. 2 represents portions of the hardware used to support the system illustrated in Fig. 1. The reasoning system and protocol may, as shown, by supported on the same computer, e.g. a unix server.

Fig. 3 shows an example of the use of the system in Fig. 2 in the context of an on-line auction.

We will now describe the logical operations performed by the reasoning system of Fig. 1. These explanations are explained in overview in Fig. 4, and in a more detailed example in Fig. 5.

S is defined as the set of all possible states (including hypotheses, and optionally also additional propositions characterizing the negotiation). The set of confidence values (and characterization variables for the additional propositions) are here represented by a set P (there is a value of P for each of the hypotheses in S). The off-line algorithm initiates P. We can then define $S'=\{s \in S;\ p(s) > 0\}$, i.e. S' is the set of all states which have a positive probability.

Another set T is defined (which we will expect to attain equilibrium behaviour and outcomes during negotiation according to the methods of the invention). The set T is normally much smaller than S (i.e. the number of elements is smaller). For each proposition in S, there is at least one link to a state in T, which carries a certain weight on it. This represents a likely causal relationship. For example, in a double auction j="No" (no big player present), is linked to the state "Competitive outcome" in T with a large probability.

Because the number of states in T is smaller than S, most states in T have several links leading to them from different states. This creates a relationship between states in S, which is based on the similarity of the equilibrium outcomes.

Once P is set (and at any given stage after P is updated):

(1) The probability of an individual state is given by the product of the probabilities in each of the categories.

(2) The probability of a set of state is equal to the sum of the probabilities of the individual states in that set.

(3) The probability of the states in T is obtained in the

following way: For each state, t' in T, we compute cp(t') - the sum of the probabilities of the states in S which link to this state, multiplied by the weights of these links. We then define the probability of state t' as

$$p(t') = \frac{cp(t')}{\sum_{t \in T} cp(t)}.$$

Therefore, after each iteration (i.e. updating of the p values) the system has a probability distribution over the outcomes and equilibrium behaviour it expects to observe.

There are two types of updating procedures:

Updating propositions based on new information (the value of some of the propositions which are "on-line" will become known, for example the number of bidders). This should be a straightforward updating of P (and therefore of S').

Updating based on observed equilibrium outcome or behaviour (this is not directly done by the system. The protocol can inform the system that certain behaviour is observed. The system, however, responds to such input by the following procedure). Here, we work backwards, and update all the states in S which link to the state in T which is now being updated. This could be negative (i.e. a state in T has a higher weight than observed) or positive (i.e. a state in T has a lower probability from what is observed. On the extreme, a state which currently

has zero probability had occurred).

The first type of updating, (normally) updates the P values associated with the states in S'. It cannot enlarge S', but could, in some cases make it smaller by setting the probability of one or more of the states in S' to zero.

The second type of updating (and sometimes also the first, although this would mean that the wrong data was given off-line), can lead to updating S' itself, by recognising that a state (or a set of states), which is not included in S' (i.e. not anticipated by the system) is now likely.

Throughout the off-line setting of P, if a "don't know" answer is given, it is possible to include a procedure which investigates the matter further by case-base matching (for example, if a "don't know" answer is given for the value of the good traded, then we can use the fact that all kinds of consumption goods, like foods, are private value and so on).

More specifically, the updating procedure is as follows:-

1. At the end of the off-line stage, the protocol (user) receives a set of states, S; a probability distribution P over that set; a set T; and a probability distribution p(T) over the set T.
2. New information about P may become available to the protocol at the on-line stage (for example, the

number of bidders may have been unknown in advance, but becomes known on-line). The protocol can transmit this new information to the invention, which in turn updates P and p(T) accordingly.

3. The above described new information is transmitted by the protocol (user) to the invention (system) in the form of new numerical values, the v's or w's, describing the probabilities of certain propositions (e.g. new probabilities for the number of bidders).

4. In addition to new information about P, the protocol can transmit to the invention updated information regarding observed negotiating behaviours and/or observed outcomes of negotiations, i.e. information regarding p(T).

5. This new information about p(T) can be used by the invention for backward updating of P and p(T) (as described below).

6. Once again, the above described new information is transmitted by the protocol to the invention using numerical values (either v's or w's) describing the observed likelihoods of states in T.

7. Both the v's and the w's serve the same purpose: transmitting new information to the invention. The main difference between the two is the following:

a) The protocol (user) may wish to completely re-write existing values in P (or p(T)), for example if the protocol learns that the number of bidders in

the on-line auction is, say, 6, then it can set P(j="4-10")=1 hence overwriting any existing values for j. In this case the protocol uses the V's.

b) The protocol may wish to update existing values, rather than replace (this is likely when continuous and gradual updating takes place. It is also the more 'natural' way to update p(T)). In this case the protocol uses the w's ("w" for "weight"), which are then used by the invention as weights for updating existing values in p, or in p(T) (as explained below)

Example 1: Double auction

A double auction is a marketplace where sellers and buyers post demand and supply functions (for example, "willing to buy 7 units at price", "selling at X per unit up to 20 units, and Y per unit for 20 or more").

(1) States of the world: S(i, j, k, l, m, n) = 5×2×3×2×4×2 = 480 states, in a six dimensional array.

Propositions:

i: Ratio of buyers to sellers, 5 states: 1 to 1, 1 to 2 or more, ratio smaller than one third, ratio between one and two thirds, ratio greater than two thirds.

j: Presence of "big" players, 2 states: Yes, No.

k: Value of object or service, 3 states: Private value, common value, correlated value.

l: Repeated interactions, 2 states: Yes, No (or not significant)

m: Outside option, 4 states: Yes for all, Only for Sellers, Only for buyers, No for all.

n: Capacity constraints, 2 states: Significant, Not significant.

The set T:

t_1: Symmetry between buyers and sellers

t_2: Asymmetric - buyer side more competitive

t_3: Asymmetric - sellers side more competitive

t_4: Competitive outcome expected

t_5: Non-competitive outcome expected

t_6: Reputation and history dependent strategies likely

(2) Initiating P: Through off-line algorithm below.

Question: Enter the estimated number of buyers and sellers (the program then computes A=abs(#sellers minus #buyers)/max(#sellers, #buyers)

Answer: 1 to 1 Action: Set p(i="1-1")=1

Answer: 1 to 2+ Action: Set p(i="1-2+")=1

Answer: A<1/3 Action: Set p(i="<1/3")=1

Answer: 1/3<A<2/3 Action: Set p(i="1/3<2/3")=1

Answer: A>2/3 Action: Set p(i=">2/3")=1

Answer: Don't know Action: Set 5*p(i="1-1")=3*p(i="1-2+")= p(i="<1/3")=2*p(i="1/3<2/3")=2*p(i=">2/3")

Answer: Manual Action: Set i.

Answer: On-line Action: Set 5*p(i="1-1")=3*p(i="1-2+")= p(i="<1/3")=2*p(i="1/3<2/3") =2*p(i=">2/3")
Set On-line=On-line $\cup$ {i}

Question: Are there "big" players present?

Answer: Yes Action: Set p(j="Yes")=1

Answer: No Action: Set p(j="No")=1

Answer: Don't know Action: Set 2*p(j="No")=p(j="Yes")

Answer: Manual Action: Set j.

Question: What is the value of the object or service traded?

Answer: Private Action: Set p(k="Private")=1

Answer: Common Action: Set p(k="Common")=1

Answer: Correlated Action: Set p(k="Correlated")=1

Answer: Don't know Action: Set p(k="Private")=10*p(k="Common")=10/9*p(k="Correlated")

Answer: Manual Action: Set k.

Answer: On-line Action: Set p(k="Private")=10*p(k="Common")=

10/9*p(k="Correlated")

Set On-line=On-line $\cup$ {k}

Question: Repeated Interaction?

Answer: Yes Action: Set p(l="Yes")=1

Answer: No Action: Set p(l="No")=1

Answer: Don't know Action: Set 4*p(l="No")=p(l="Yes")

Answer: Manual Action: Set l.

Question: Outside option?

Answer: Yes to all Action: Set p(m="YAll")=1

Answer: Sellers only Action: Set p(m="Sellers")=1

Answer: Buyers only Action: Set p(m="Buyers")=1

Answer: No to all Action: Set p(m="NAll")=1

Answer: Don't know Action: Set p(m="Yall")=3*p
(m="Sellers")= 3*p
(m="Buyers")=p(m="NAll").

Answer: Manual Action: Set m.

Answer: On-line Action: Set p(m="Yall")=3*p
(m="Sellers")= 3*p
(m="Buyers")=p(m="NAll").
Set On-line=On-line $\cup$ {m}

Question: Capacity constraints?

Answer: Significant	Action: Set p(n="Sign")=1
Answer: Not significant	Action: Set p(n="No")=1
Answer: Don't know	Action: Set p(n="Sign")=p (n="No")
Answer: Manual	Action: Set n.
Answer: On-line	Action: Set p(n="Sign")=p (n="No") Set On-line=On-line $\cup$ {n}

To explain the notation used here, and in the remainder of the document, when a proposition has two possibilities, each described by a respective confidence value p, and we say that the value of p for one of those possibilities is set to 0 or 1, it is to be understood that the value of p for the other of those possibilities is respectively set to 1 or 0. More generally, in the invention during the initiation of confidence values, they are preferably initiated so as to be normalised. Thus, for example, when it is stated above that we set 2*p(j="No")=p(j="Yes"), we mean that p(j="No") is set to 1/3 and p(j="Yes") is set to 2/3. Similarly, when we say that we set p(k="Private")=10*p(k="Common")=10/9*p (k="Correlated"), we mean that p(k="private") is set to ½, p(k="Common") is set to 1/20, and p(k="Correlated") is set to 9/20.

Stage 2: Set the following links:

FROM: i="1-1"	TO: t_1	WEIGHT: 0.5
FROM: i="1-1"	TO: t_4	WEIGHT: 1

FROM: i="1-2+" TO: t_2 WEIGHT: 0.8

FROM: i="1-2+" TO: t_3 WEIGHT: 0.8

FROM: i="<1/3" TO: t_1 WEIGHT: 0.8

FROM: i="<1/3" TO: t_4 WEIGHT: 0.9

FROM: i="1/3<2/3" TO: t_2 WEIGHT: 0.5

FROM: i="1/3<2/3" TO: t_3 WEIGHT: 0.5

FROM: i="1/3<2/3" TO: t_4 WEIGHT: 0.5

FROM: i=">2/3" TO: t_2 WEIGHT: 0.9

FROM: i=">2/3" TO: t_3 WEIGHT: 0.9

FROM: i=">2/3" TO: t_5 WEIGHT: 0.9

FROM: j="Yes" TO: t_5 WEIGHT: 0.8

FROM: j="Yes" TO: t_6 WEIGHT: 0.8

FROM: j="No" TO: t_4 WEIGHT: 0.5

FROM: k="Private" TO: t_4 WEIGHT: 0.7

FROM: k="Common" TO: t_5 WEIGHT: 0.8

FROM: k="Correlated" TO: t_5 WEIGHT: 0.6

FROM: l="Yes" TO: t_5 WEIGHT: 0.8

FROM: l="Yes" TO: t_6 WEIGHT: 1

FROM: l="No" TO: t_4 WEIGHT: 0.5

FROM: m="YAll" TO: t_1 WEIGHT: 0.7

FROM: m="Buyers" TO: t_3 WEIGHT: 0.9

FROM: m="Sellers" TO: t_2 WEIGHT: 0.9

FROM: m="NAll" TO: t_1 WEIGHT: 0.5

FROM: m="NAll" TO: t_4 WEIGHT: 0.6

FROM: n="Yes" TO: t_5 WEIGHT: 0.8

FROM: n="No" TO: t_4 WEIGHT: 0.5

(3) Updating rules:

Type I:

These will be described later.

Type II:

These will be described later.

Example 2: Scheduling (one-to-one negotiations)

(1) States of the world: S(i,j,k,l,m) = 3x3x2x2x3=108 states, in a four dimensional array.

Propositions:

i: Outside option, 3 states: none/one of the players/both players.

j: Deadlines, 3 states: none/ one of the players/both players.

k: Patience attitudes, 2 states: significant differences/no significant difference.

l: Repeated interactions, 2 states: yes/no.

m: Strategic complimentarities, 3 states: no conflict/some conflict/opposite preferences.

The set T:

t_1: Extreme ex-ante asymmetry (no bargaining)

t_2: Ex-ante asymmetry (both sides have some bargaining power)

t_3: Symmetric ex ante bargaining

t_4: Value of surplus compared to value of deal significant

t_5: Value of surplus compared to value of deal not significant

t_6: Reputation and history dependent strategies likely

(2) Initiating P: Through off-line algorithm below.

Question: Outside option?	
Answer: None	Action: Set p(i="None")=1
Answer: One of the players	Action: Set p(i="OneSide")=1
Answer: Both players	Action: Set p(i="Both")=1
Answer: Don't know	Action: Set p(i="None")=p(i="OneSide")=p(i="Both")
Answer: Manual	Action: Set i.

Answer: On-line Action: Set p(i="None")=p
(i="OneSide")=p(i="Both")
Set On-line=On-line ∪ {i}

Question: Deadlines?

Answer: None Action: Set p(j="None")=1

Answer: One of the players Action: Set p(j="OneSide")=1

Answer: Both players Action: Set p(j="Both")=1

Answer: Don't know Action: Set p(j="None")=3*p
(j="OneSide")=3*p
(j="Both")

Answer: Manual Action: Set j.

Answer: On-line Action: Set p(j="None")=p
(j="OneSide")=p(j="Both")
Set On-line=On-line ∪ {j}

Question: Patience attitude of bargaining parties?

Answer: Significant difference Action: Set p(k="Sign")=1

Answer: No significant difference Action: Set p(k="No")=1

Answer: Don't know Action: Set p(k="No")=3*p
(k="Sign")

Answer: Manual Action: Set k.

Answer: On-line Action: Set p(k="No")=3*p
(k="Sign")
Set On-line=On-line
∪ {k}

Question: Repeated interactions?

Answer: Yes Action: Set p(l="Yes")=1

Answer: No Action: Set p(l="No")=1

Answer: Don't know Action: Set 4*p(l="No")=p(l="Yes")

Answer: Manual Action: Set l.

Question: Strategic complimentarities?

Answer: No conflict Action: Set p(m="NoConf")=1

Answer: Some conflict Action: Set p(m="Mix")=1

Answer: Opposit preferences Action: Set p(m="Opp")=1

Answer: Don't know Action: Set p(m="NoConf")=p(m="Mix")=p(m="Opp")

Answer: Manual Action: Set m.

Answer: On-line Action: Set p(m="NoConf")=p(m="Mix")=p(m="Opp")
Set On-line=On-line $\cup$ {m}

Stage 2: Set the following links:

FROM: i="None" TO: t_3 WEIGHT: 0.8

FROM: i="OneSide" TO: t_1 WEIGHT: 0.2

FROM: i="OneSide" TO: t_2 WEIGHT: 0.5

FROM: i="Both" TO: t_3 WEIGHT: 0.8

FROM: j="None" TO: t_3 WEIGHT: 0.8

FROM: j="OneSide" TO: t_1 WEIGHT: 0.2

FROM: j="OneSide" TO: t_2 WEIGHT: 0.5

FROM: j="Both"	TO: t_3	WEIGHT: 0.8	
FROM: k="No"	TO: t_3	WEIGHT: 0.8	
FROM: k="Sign"	TO: t_1	WEIGHT: 0.2	
FROM: k="Sign"	TO: t_2	WEIGHT: 0.5	
FROM: l="Yes"	TO: t_6	WEIGHT: 0.8	
FROM: m="NoConf"	TO: t_5	WEIGHT: 1	
FROM: m="Some"	TO: t_4	WEIGHT: 0.2	
FROM: m="Some"	TO: t_5	WEIGHT: 0.2	
FROM: m="Opp"	TO: t_4	WEIGHT: 1	

(3) Updating rules:

Type I:

These will be described later.

Type II:

These will be described later.

Example 3: On-line auction houses

An on-line auction is a situation where one seller (or buyer), sells (or buys) a good or service through an

auction protocol, to 2 or more potential buyers (sellers).

Auctions are among the simplest cases of a trading environment because there are only a relatively small number of factors which influence the underlying incentive structure of participating agents.

(1) Defining states of the world

To set up the example we consider a model of the world (the trading environment) in which the states of the world are given by a seven dimensional array S(i, j, k, l, m, n, o, p). Addressing these variables in turn,

-Index i (which has two states) represents whether the method is used for buying or selling?

-Index j represents the number of other parties (buyers or sellers)? Index j is an integer which can take 5 values(representing whether the number of players is 2, 3, 4-10, 11-20, or 21 or more).

-Index k represents whether there big players, or only small? Thus, k has 2 states.

-Index l represents whether an object or a service is being traded. It thus has 2 states.

-Index m has 3 states and labels whether the goods are single unit, multi-unit sold sequentially or multi-unit sold simultaneously?

-Index n represents whether value is private value, common value, or correlated value? It has 3 states.

-Index o represents whether trading is made up of repeated interactions (in a way that matters). Index n has 2 states.

-Index p represents whether there is a outside option (e.g. competition between auctions) It has 2 states: Yes, No (or not significant).

Thus there are 2x5x2x2x3x3x2x2 = 1440 possible world states.

Set T:

t_1: Competitive environment

t_2: Non-competitive environment

t_3: Surplus extraction possible

t_4: Reputation and history dependent strategies likely.

(2) Initiating P: Through off-line algorithm below.

Question: Buying or Selling?

Answer: Buying Action: Set p(i="Buying")=1

Answer: Selling Action: Set p(i="Selling")=1

Answer: Manual Action: Set i.

Answer: On-line Action: Set p(i="buying")=p (i="selling")

Set On-line=On-line $\cup$ {i}

Question: Number of bidders 2,3,4-10,11-20,more than 20?

Answer: 2 Action: Set p(j="2")=1

Answer: 3 Action: Set p(j="3")=1

Answer: 4-10 Action: Set p(j="4-10")=1

Answer: 11-20 Action: Set p(j="11-20")=1

Answer: 20+ Action: Set p(j="20+")=1

Answer: Manual Action: Set j.

Answer: On-line Action: Set p(j="2")=p(j="3")=p(j="4-10")
=p(j="11-20")=p(j="20+")
Set On-line=On-line $\cup$ {j}

Answer: Don't know Action: Set p(j="2")=p(j="3")=p(j="4-10")=p(j="11-20")=p(j="20+")

Question: Are there big players present?

Answer: Yes Action: Set p(k="No")=0

Answer: No Action: Set p(k="Yes")=0

Answer: Don't know Action: Set 5*p(k="Yes")=p(k="No")

Question: Object or Service?

Answer: Object Action: Set p(l="Service")=0

Answer: Service Action: Set p(l="Object")=0

Answer: Manual Action: Set j.

Answer: On-line Action: Setp(l="Service")=p (l="Object")
Set On-line=On-line $\cup$ {l}

Question: Single unit, multi-unit sold simultaneously, multi-unit sold sequentially?

Answer: Single Action: Set p(m="Single")=1

Answer: Multi-sim Action: Set p(m="Multi-sim")=1

Answer: Multi-seq Action: Set p(m="Multi-seq")=1

Answer: Manual Action: Set m.

Answer: On-line Action: Set p(m="Single")= p(m="Multi-sim")= p(m="Multi-seq")
Set On-line=On-line $\cup$ {m}

Question: Private, common or correlated value?

Answer: Private Action: Set p(n="Private")=1

Answer: Common Action: Set p(n="Common")=1

Answer: Correlated Action: Set p(n="Correlated")=1

Answer: Manual Action: Set n.

Answer: Don't know Action: Set p(n="Private")=10*p(n="Common")=10/9*p(n="Correlated")

Answer: On-line Action: Set p(n="Private")=10*p(n="Common")=10/9*p(n="Correlated")
Set On-line=On-line $\cup$ {n}

Question: Repeated game?

Answer: Yes Action: Set p(o="No")=0

Answer: No Action: Set p(o="Yes")=0

Answer: Manual Action: Set o.

Answer: Don't know Action: Set p(o="No")=10*p(o="Yes")

Question: Competition with other auction sites?

Answer: Significant Action: Set p(p= "No")=0

Answer: Not sig. Action: Set p(p="Yes")=0

Answer: Manual Action: Set p.

Answer: Don't know Action: Set p(p="No")=p(p="Yes")

Stage 2: Set the following links:

FROM: j="2"	TO: t_2	WEIGHT: 1
FROM: j="3"	TO: t_2	WEIGHT: 0.8
FROM: j="4-10"	TO: t_2	WEIGHT: 0.5
FROM: j="4-10"	TO: t_1	WEIGHT: 0.5
FROM: j="11-20"	TO: t_1	WEIGHT: 0.8
FROM: j="11-20"	TO: t_3	WEIGHT: 0.5
FROM: j="20+"	TO: t_1	WEIGHT: 1
FROM: j="20+"	TO: t_3	WEIGHT: 0.8

FROM: k="Yes"	TO: t_2	WEIGHT: 0.6
FROM: k="Yes"	TO: t_4	WEIGHT: 1
FROM: k="No"	TO: t_1	WEIGHT: 0.7

FROM: k="No" TO: t_3 WEIGHT: 0.4

FROM: n="Private" TO: t_1 WEIGHT: 0.7
FROM: n="Common" TO: t_2 WEIGHT: 0.8
FROM: n="Correlated" TO: t_2 WEIGHT: 0.6

FROM: o="Yes" TO: t_2 WEIGHT: 0.6
FROM: o="Yes" TO: t_4 WEIGHT: 1
FROM: o="No" TO: t_1 WEIGHT: 0.7
FROM: o="No" TO: t_3 WEIGHT: 0.4

FROM: p="Yes" TO: t_1 WEIGHT: 0.8
FROM: p="No" TO: t_2 WEIGHT: 0.1
FROM: p="No" TO: t_3 WEIGHT: 0.6

(3) Updating rules:

Type I:

See later

Type II:

See later

Updating

Two methods which may be employed for updating the p values (i.e. type 1 updating) in the examples above, will now be explained.

Note that the user referred to in the following two examples is not one of the negotiating parties, but rather the protocol itself (i.e. the system which mediates between the negotiating parties).

Method I: Forward on-line updating

For each proposition in the set {On-line} the system invites the user to input values on-line. (In addition, the user can at any stage, update the value associated with any of the propositions).

The following procedures is applied when a proposition, say j, is being updated On-line:

Denote by j_1, j_2, ...j_N the possible values of proposition j (for example: for the proposition "number of bidders" in example 3 there are five possible values: "2", "3", "4-10", "11-20", and "20+").

The system asks the user whether the old values should be overwritten or updated (note that at the on-line stage all propositions have been assigned initial values):

If overwritten:

(1)User enters new values $v(j_1)$, $v(j_2)$, ...$v(j_N)$, which

satisfy $v(j_i) \geq 0$ for all i=1, ...N. At least one of these values is strictly positive and $\sum_{i=1,..,N} v(j_i) < 1$.

(2)For all $v(j_i)=0$, set:

$$p^{new}(j = j_i) = \left(1 - \sum_{k \in 1,..,N} v(j_k)\right) \frac{p^{old}(j = j_i)}{\sum_{k \in 1,..,N \text{ and } v(jk)=0} p^{old}(j = j_k)}$$

If updated:

(1)User enters updating weights $w(j_1)$, $w(j_2)$, ... $w(j_N)$. At least one of which is different from zero.

(2)Set $p^{old}(j=j_1)=p^{old}(j=j_1)+w(j_1)$ for j=1, ...N

(3)Set

$$p(j = j_i) = \frac{p^{old}(j = j_i)}{\sum_{i=1,..,N} p^{old}(j = j_i)}$$

Method II: Backward On-line updating.

The following procedures is applied when the probability of one of more of the states in T is being updated On-line:

Denote by t_1, t_2, ... t_N the possible states in T.

STAGE I

As in the forward updating procedures, the system asks

the user whether the old values should be overwritten or updated:

(1)User enters new values $v(t_1)$, $v(t_2)$, ... $v(t_N)$, which must satisfy $v(t_i) \geq 0$ for all i+1,...,N. At least one of these values is strictly positive, and

$$\sum_{i=1,..,N} v(t_i) < 1.$$

(2)For all v(ti)=0, set:

$$p^{new}(t_i) = \left(1 - \sum_{k \in 1,..,N} v(t_k)\right) \frac{p^{old}(t_i)}{\sum_{k \in 1,..,N \text{ and } v(Tk)=0} p^{old}(t_k)}$$

If updated:

(1)User enters updating weights $w(t_1)$, $w(t_2)$, ... $w(t_N)$. At least one of which is different from zero.

(2)Set $p^{old}(t_i)=p(t_i)+W(t_i)$ for i=1 ...., N

(3)Set

$$p(t_i) = \frac{p^{old}(t_i)}{\sum_{j=1,..,N} p_{old}(t_j)}.$$

STAGE 2

For each state t_i such that $p(t_i)$ had changed, find all links which lead to it (for example, for t_1 in example 1, there are 4 links which lead to it: from m="YAll", from m="NAll", from i="1-1" and from 1="<1/3").

Denote these links by L_{i1}, L_{i2}, ... L_{iN} and by $P(L_{ij})$ the

specific value that this link leads from, and by ($V(L_{ij})$ the specific value of that proposition which triggers the link (for example, for the link from m="NAll" to T1, $P(L_{ij})$ is m, and $V(L_{1,4})$ is "NAll"). Finally, denote by $S(L_{ij})$ the weight associated with the link L_{ij}.

(1) Set:

$$p^{new}(V(L_{ij}) = P(L_{ij})) = \left(p^{old}(t_i) - p^{new}(t_i)\right).\frac{S(L_{ij})}{\sum_{k=1,..,N} S(L_{ik})}.p(V(L_{ij}) = P(L_{ij}))$$

(2) Normalise the probabilities:

For each proposition for which the above probability of at least one of the possible outcomes had changed as a result of the above calculations, the following normalising procedure will be carried out:

Denote the proposition by j, and the possible outcomes as $j_1, j_2 \ldots j_N$.

Set

$$p(j = j_i) = \frac{p^{old}(j = j_i)}{\sum_{k=1,..,N} p^{old}(j = j_k)}.$$

If all links lead to event which have zero probabilities the above calculations will not work (division by zero).This implies that an event with zero probability

now becomes likely (or even already occurred). In this case, the set S' and the probabilities P are re-computed, by informing the user and re-doing the appropriate off-line algorithm.

Example 4

Example 4 is a detailed example of how a system such as that shown in Fig. 1 within the scope of the invention may use the communication protocol to regulate negotiations between self-interested agents: to diagnose and fix inefficiencies.

First, consider the example of an auction protocol. Here self-interested agents, representing different individuals and/or organisations, bid according to the rule specified by the protocol, in order to get the objects or services that are being auctioned.

Using the sets S, T, and the weights P (which are explained in detail in examples 1-3), the protocol is initiated with the information that there are no big players present, and that the game is not repeated. For example, the following values are entered by the user (protocol):

p(i="selling")=1

p(i="4-10")=1

p(k="No")=1

p(l="object")=1

p(m="single value")=1

p(n=private value")=1

p(o="No")=1

p(p="No")=1

This, with the rest of the information induces a distribution over the states in T. In particular, the probabilities of states t_1 and t_3 will be close (or even equal) to 1, while the probabilities of states t_2 and t_4 will be close to zero. The protocol then chooses, based on available information, to use an English auction protocol.

An English auction protocol incrementally raises the asking price for the object/service. At each price agents can drop out from bidding (i.e. the current asking price is deemed too high for their users). When all agents but one dropped out, the remaining agent wins the object. An English auction is efficient and maximises the expected revenues for the seller when there are no signalling and price rigging by bidders, for example when there are no big players who interact repeatedly.

Suppose however, that there is signalling between big players, for example, the agent of organisation B drops out immediately when the agent representing organisation A starts bidding for an object, and that in the next round, A drops out when B starts bidding. This type of behaviour is possible in an English auction because agents can observe each other's bidding. This inefficiency will be recognised by the invention, because

the observed outcomes (for example the revenues generated by the auction protocol) correspond to states in T which have zero (or close to zero) weighting. Specifically, the auction protocol, which follows bidding histories and outcomes, transmits the following information, based on this observation, to the reasoning system: $v=(t1)=0.05$, $v(t_2)=0.4$ $v(t_3)=0$ $v(t_4)=0.5$. Using the backward on-line updating (as described above), the reasoning system detects a mismatch (technically, this happens when the formula for updating involves dividing by zero). The reasoning system then transmits to the communication protocol the information of this mismatch and the likely reason (i.e. "Observed behaviour is not consistent with current S", probably because there are big players present, or the bidders signal through repeated interactions).

The protocol can respond to this information by changing its bidding protocol from an English auction to, for example, a sealed bid auction where agents submit secretly bids representing the price their users are willing to pay for the auctioned object or service. Signalling between agents is much more difficult in a sealed bid auction, and this change is therefore likely to restore efficiency, and increase expected revenues for sellers.

Another way in which the invention can be used by the communication protocol to regulate negotiations

between self-interested agents will now be given in the context of direct one-to-one negotiations. Suppose that a multi-agent system (MAS) uses an alternating-offers protocol for direct negotiations between agents. That is, each agent in its turn either accepts the current offer or rejects it and makes a counter offer. The process of offers and counter offers continues until one of the agents accepts an offer, which is then implemented. Suppose further that the MAS uses this protocol for co-ordination of the usage of a limited resource between different individuals. For example, individuals within an organisation which negotiate the usage of the meeting room, or access to busy Internet connection, and so on.

Generally speaking, the alternating-offers protocol is efficient if agreements are reached quickly, i.e. within a small number of rounds of offers and counter-offers. If agents tend to not make concession, the protocol can be very inefficient, because the network resources used by agents to carry out these fruitless negotiations are effectively wasted. The invention can be used to detect such inefficiencies. The invention, as used for direct negotiations (as explained above), expects agreement to be reached relatively quickly because agents expect to negotiate according to their bargaining power (as determined by the underlying strategic considerations like outside offers, and so on).

If the invention detects that this is not the case - the observed behaviour differs considerably from that induced by the distribution over the set of outcomes T - then this information can be transmitted to the protocol which governs agents' communications. The protocol can change the alternating-offers protocol to, for example, a more centralised protocol where all agents submit their request for using the limited resource, and the protocol then returns a resource allocation scheme based on some given algorithm (for example, a "first come first served" algorithm).

Example 5

Example 5 is an explanatory example of how a system such as that shown in Fig. 6 within the scope of the second aspect of the invention is used by a single organisation to control its own bidding strategy.

The general definitions described in relation to examples 1 to 3 are still valid for this use of the invention, with the difference that the set T now represent the set of available bidding strategies. Once P and S are set, the values of states in T' can be computed (see stage (3) above). These weights now represent not the likelihood of these behaviours in equilibrium (as in the above examples), but rather, the likelihood of these strategies being optimal <u>for the organisation</u> (in the sense that they lead to maximising

revenues or profits).

Fig. 6 illustrates schematically an example of how the invention fits with the other purchasing support software used by the organisation. The system comprises three portions, a section 11 made up of IT systems which are well known in the field of automatic trading agents, an interface and integration section 13 of additional IT components, and a reasoning system 15 which is an apparatus according to the invention.

The section 11 in this figure comprises an enterprise resources planning and supply chain ("ERP"), a database, and an internet procurement device.

Section 13 is a user interface, which also coordinates the interaction of the reasoning system 15 with the known agent systems 11.

Upon a request 17 being submitted to the section 13 (e.g. "buy 100 tonnes of sugar"), the request is processed and integrated with existing software 11 (for example, although in the figure the user request 17 is shown arriving from outside, e.g. from a human user, the request 17 might alternatively be generated by the ERP.

The reasoning section 15 reasons as described below and above, and makes a decision of who to buy from, how much to buy from each seller, and what bidding/negotiating strategy is most likely to work.

For example, as shown schematically in Fig. 6, the reasoning system may decide to bid in a certain auction,

to buy at a fixed price from a certain seller, to open up direct negotiation with a certain seller, or to transmit to a certain seller a request for that seller to name his price.

As a specific instance, consider a corporate buyer requiring a large number of units of some manufacturing materials (say 100 tones of cement, or 500 tones of sugar, and so on). The corporate can buy from any of three approved vendors, and/or from an on-line auction site specialising in these materials. A strategy therefore consists of how much to bid in the auction and how to negotiate with each of the approved vendors (assuming at least some features of the deal, like prices or delivery date, are negotiable. This assumption is realistic in most corporate purchasing scenarios). For example, one strategy would be to bid aggressively in the auction and to act "tough" in all three direct negotiations (for example, insisting on getting a volume discount). Of course this strategy will be successful only if the corporate is likely to win the auction (because its bid is higher than all the other participants). Otherwise it might be better to be more flexible while negotiating with at least one of the approved vendors, in case the corporate will end up buying there (for example because it did not win the auction, or because it only managed to secure a small number of units from the auction, which is not sufficient

for its needs).

In this example, the set S will contain information on (1) whether the interactions are repeated or not (2) does vendor A respond to negotiations (and similarly for vendors B and C) (3) the type of auction mechanism used (4) the relative market power of the organisation. And so on. Once S and P are set, the values of states T can be computed. The distribution over these states correspond to the estimated likelihood of the various negotiation strategies to be optimal for the organisation, given the available information. On-line, once negotiations starts, these states can be updates backwards and forwards, as explained in relation to examples 1 to 3. At any stage, the organisation can use the invention to select its bidding and negotiating strategy.

Fig. 7 shows how an embodiment of the invention can be used by a single corporate buyer.

Claims

1. A method of regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

2. A method according to claim 1 in which the negotiating parties negotiate according to a set of rules, and said regulation includes varying the set of rules based on said one or more confidence values.

3. A method according to claim 2 in which the set of rules are varied upon said one or more confidence values indicating a high likelihood of the negotiation reaching a predetermined disadvantageous condition.

4. A method of negotiation with one or more other negotiating parties by communication using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating

environment, the propositions including one or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

negotiating based on said one or more confidence values.

5. A method according to claim 4 in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to select one of a number of predetermined negotiating options.

6. A method according to claim 4 or claim 5 in which said step of negotiating based on said one or more confidence values comprises using said one or more confidence values to determine a numerical proposition which characterises an offer.

7. A method according to any preceding claim which includes at least once performing the additional step of re-evaluating said one or more confidence values based on observed characteristics of said negotiation.

8. A method according to any preceding claim comprising a step, before said step of deriving confidence values, of deriving at least some of the set of negotiating propositions based on characteristics of the negotiating environment.

9. A method according to claim 8 in which the method includes a re-evaluation step of altering the one or more hypotheses, followed by a re-derivation of confidence values for the new set of hypotheses.

10. A method according to claim 9 in which the re-evaluation step is performed upon detecting an inconsistency between the confidence values and new information, the re-evaluation eliminating the inconsistency with the new information.

11. A method according to claim 10 in which said step of altering the one or more hypotheses includes evaluating the importance of new information, and altering the hypotheses in the case that the information is evaluated to be important.

12. A method according to claim 11 in which the one or more hypotheses concern one or more of (i) characteristics of the bargaining power of one or more further negotiating parties, (ii) characteristics of agents involved in the negotiation (e.g. based on past experience), or (iii) are based on types of goods or services which are a subject of the negotiation.

13. A method according to any preceding claim further including a step of normalising the confidence values.

14. A method according to any preceding claim in which, in addition to the one or more hypotheses, the negotiating propositions further include additional propositions which characterize the negotiation process,

the additional propositions being in terms of numerical characterization variables, and the method including a step of setting the characterization variables.

15. A method of monitoring a negotiation using an electronic communication network, in which a plurality of negotiating parties negotiate regulated by a set of negotiating propositions including one or more hypotheses, the method including identifying, by comparing the actual negotiation to the negotiating propositions, a characteristic of the negotiation.

16. A method according to claim 15 in which the characteristic is a liability of the negotiation to inefficiency in time and/or revenue generated.

17. A method according to claim 15 or claim 16 including the further step of transmitted the characteristic to one or more of the parties, to cause that party to modify its behaviour.

18. A method according to any preceding claim in which the parties are self-interested agents interacting using an electronic communication network.

19. A method according to claim 18 in which the agents are automatic agents.

20. A method of linking available data and expected behaviour of self-interested agents interacting using an electronic communication network, the method employing a set of negotiating propositions characterizing a negotiating environment, the propositions including one

or more hypotheses, and the method having the steps of:

for each of said one or more hypotheses deriving a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

linking available data and expected behaviour of said agents based on said one or more confidence values.

21. An apparatus for regulating negotiation between two or more negotiating parties which communicate using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses;

means for deriving for each of said one or more hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for regulating the negotiation between said negotiating parties using said electronic communication network, based on said one or more confidence values.

22. An apparatus for negotiating with one or more other negotiating parties by communication using an electronic communication network, the apparatus having:

means for storing a set of negotiating propositions characterizing a negotiating environment, the propositions including one or more hypotheses:

means for deriving for each of said one or more

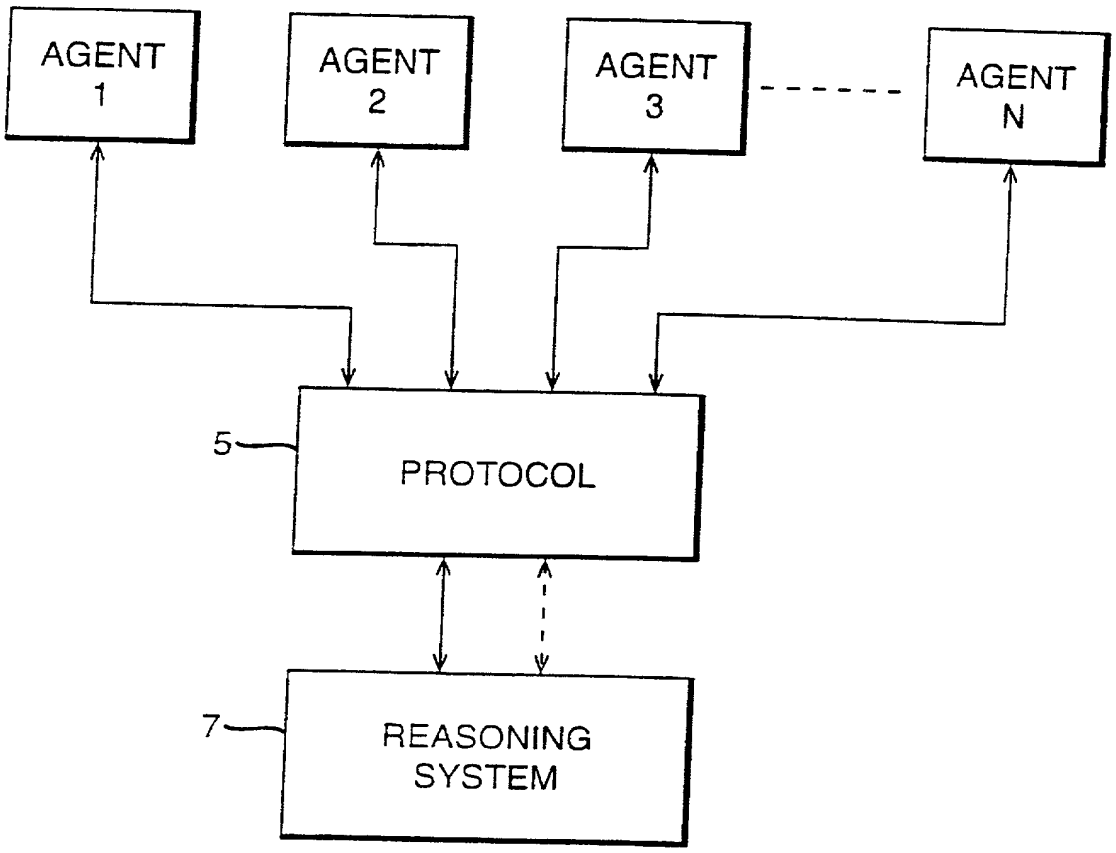
hypotheses a respective numerical confidence value, the or each confidence value representing confidence in the truth of the respective hypothesis; and

means for electronically negotiating based on said one or more confidence values.

23. An apparatus according to claim 21 or claim 22 which is electronically connected to the world wide web.

24. A computer program product readable by a computer device for causing the computer device to perform a method according to any of claims 1 to 20.

FIG. 1


AGENT 1
AGENT 2
AGENT 3
AGENT N
5
PROTOCOL
7
REASONING SYSTEM
ON-LINE COMMUNICATION
OFF-LINE COMMUNICATION

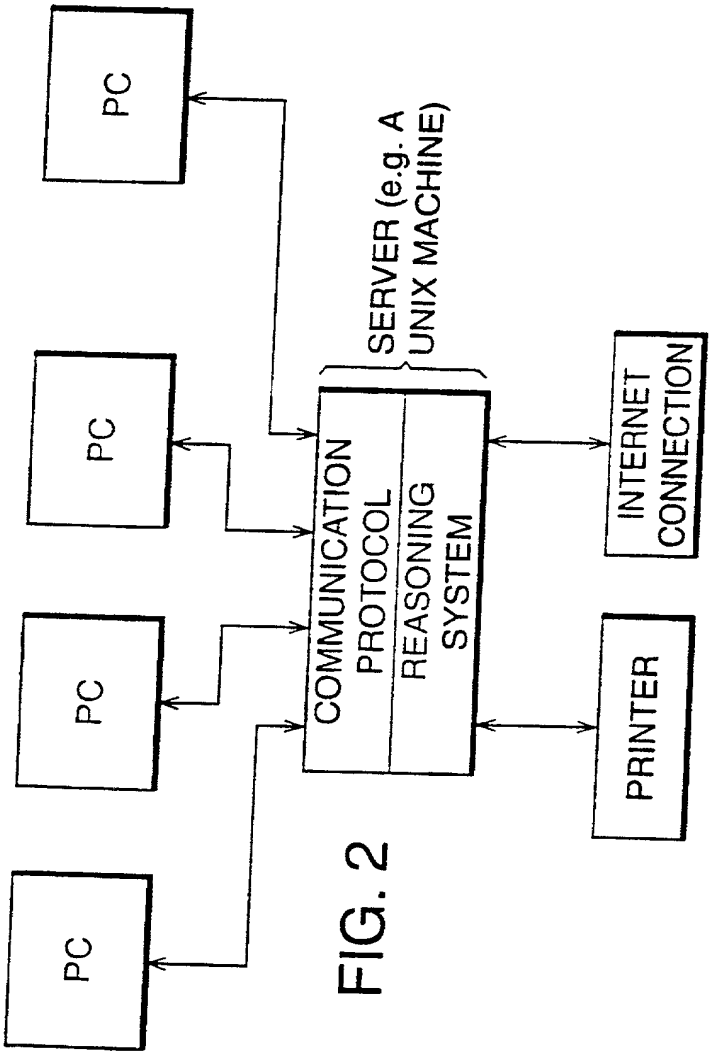

PC
PC
PC
PC
SERVER (e.g. A UNIX MACHINE)
COMMUNICATION PROTOCOL
REASONING SYSTEM
INTERNET CONNECTION
PRINTER

FIG. 2

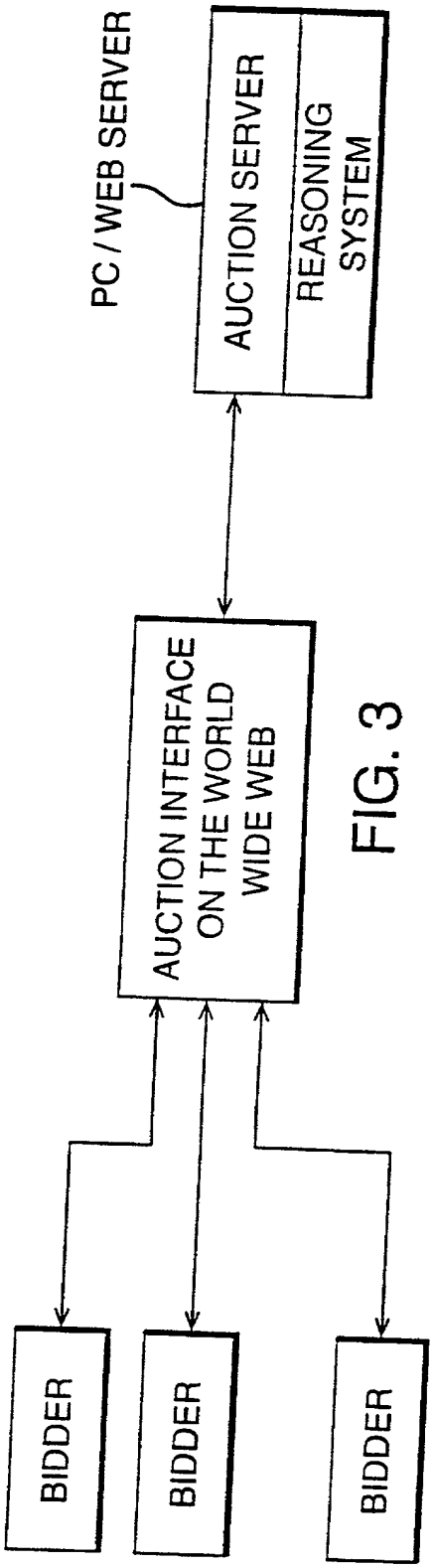

PC / WEB SERVER
AUCTION SERVER
REASONING SYSTEM
AUCTION INTERFACE ON THE WORLD WIDE WEB
BIDDER
BIDDER
BIDDER

FIG. 3

FIG. 4

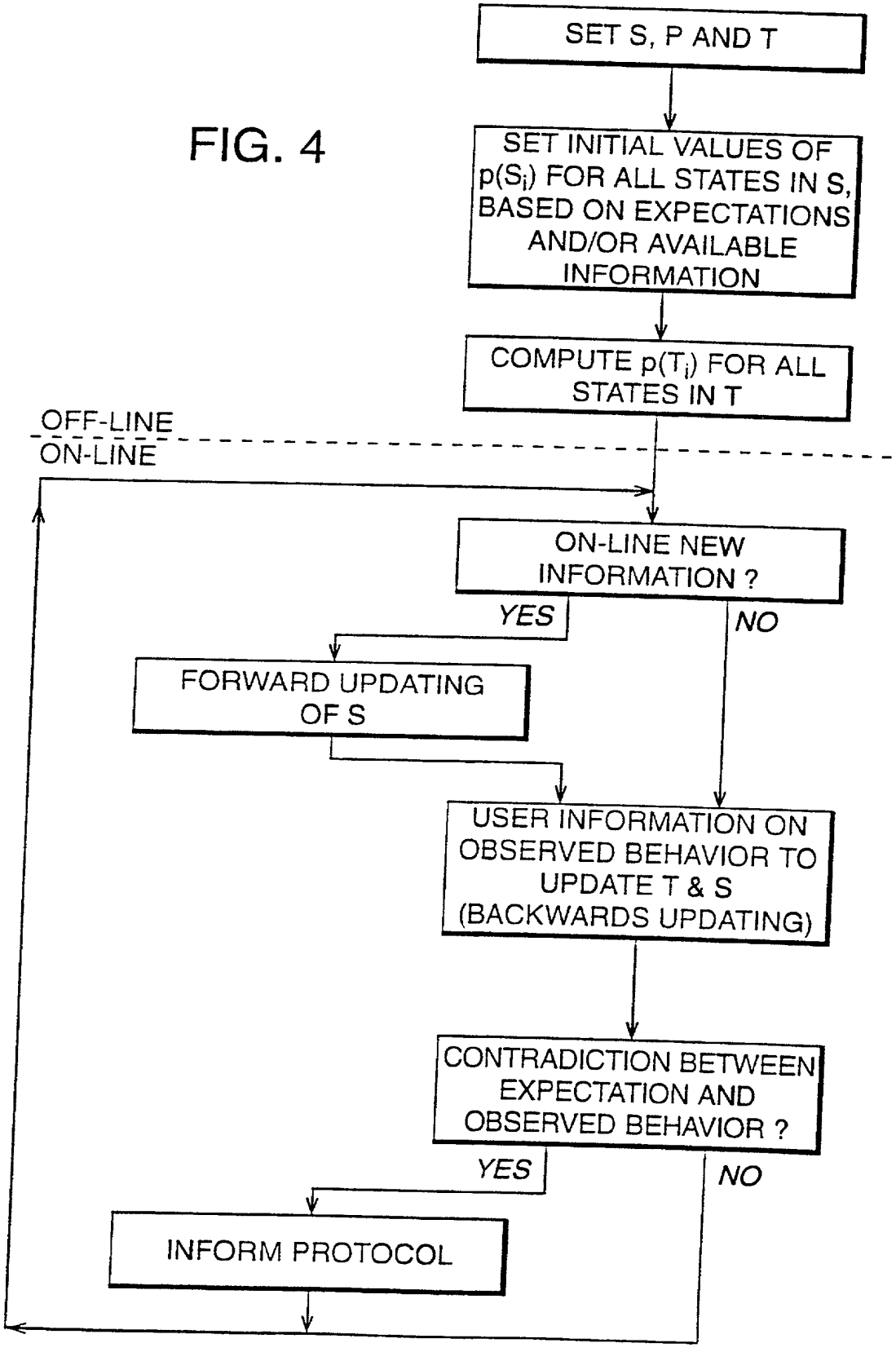

SET S, P AND T
SET INITIAL VALUES OF $p(S_i)$ FOR ALL STATES IN S, BASED ON EXPECTATIONS AND/OR AVAILABLE INFORMATION
COMPUTE $p(T_i)$ FOR ALL STATES IN T
OFF-LINE
ON-LINE
ON-LINE NEW INFORMATION ?
YES
NO
FORWARD UPDATING OF S
USER INFORMATION ON OBSERVED BEHAVIOR TO UPDATE T & S (BACKWARDS UPDATING)
CONTRADICTION BETWEEN EXPECTATION AND OBSERVED BEHAVIOR ?
YES
NO
INFORM PROTOCOL

FIG. 5(a)

OVERVIEW OF THE INTERNAL STRUCTURE OF THE INVENTION

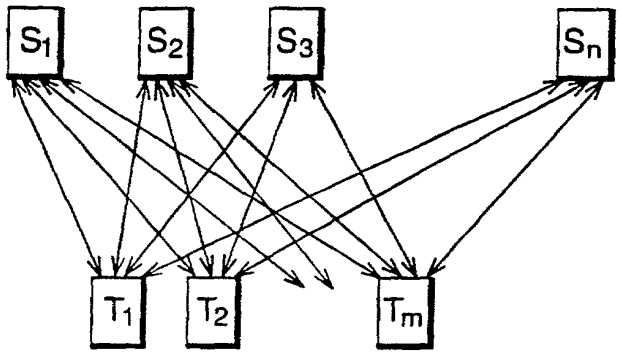


FIG. 5(b)

STAGE 1: USER ENTERS AVAILABLE OFF-LINE INFORMATION:
SYSTEM INITIALISES VALUES FOR STATES IN S

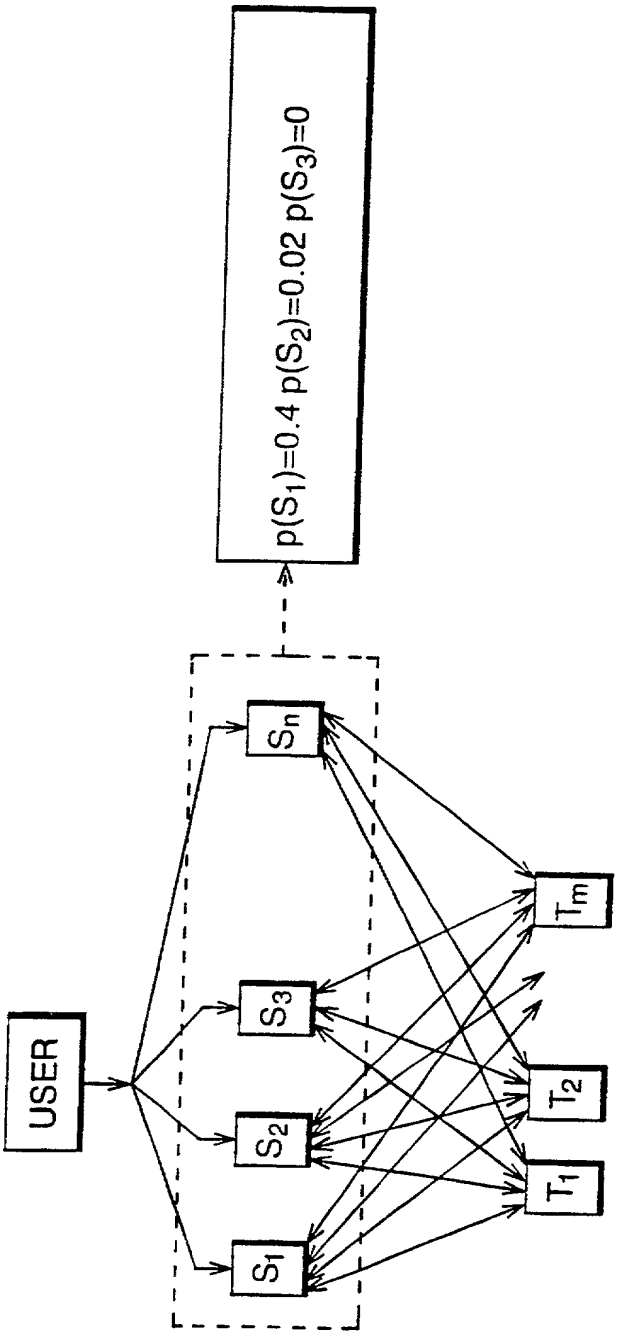


FIG. 5(c)

STAGE 2: SYSTEM COMPUTERS THE PROBABILITIES OF THE ELEMENTS IN T

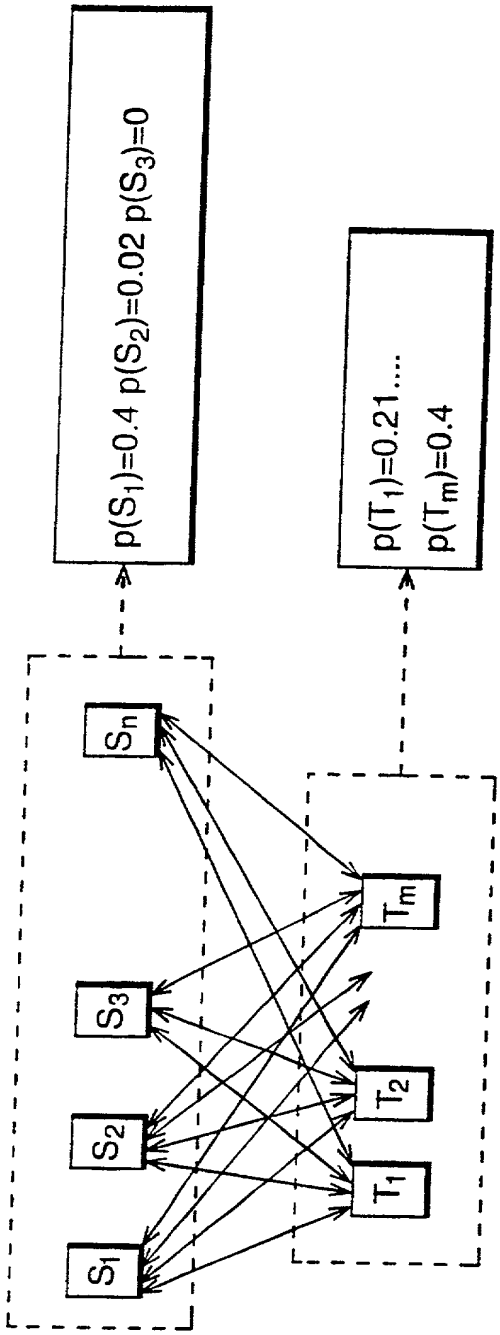


FIG. 5(d)

STAGE 3: ON-LINE INFORMATION IS USED FOR FORWARD UPDATING

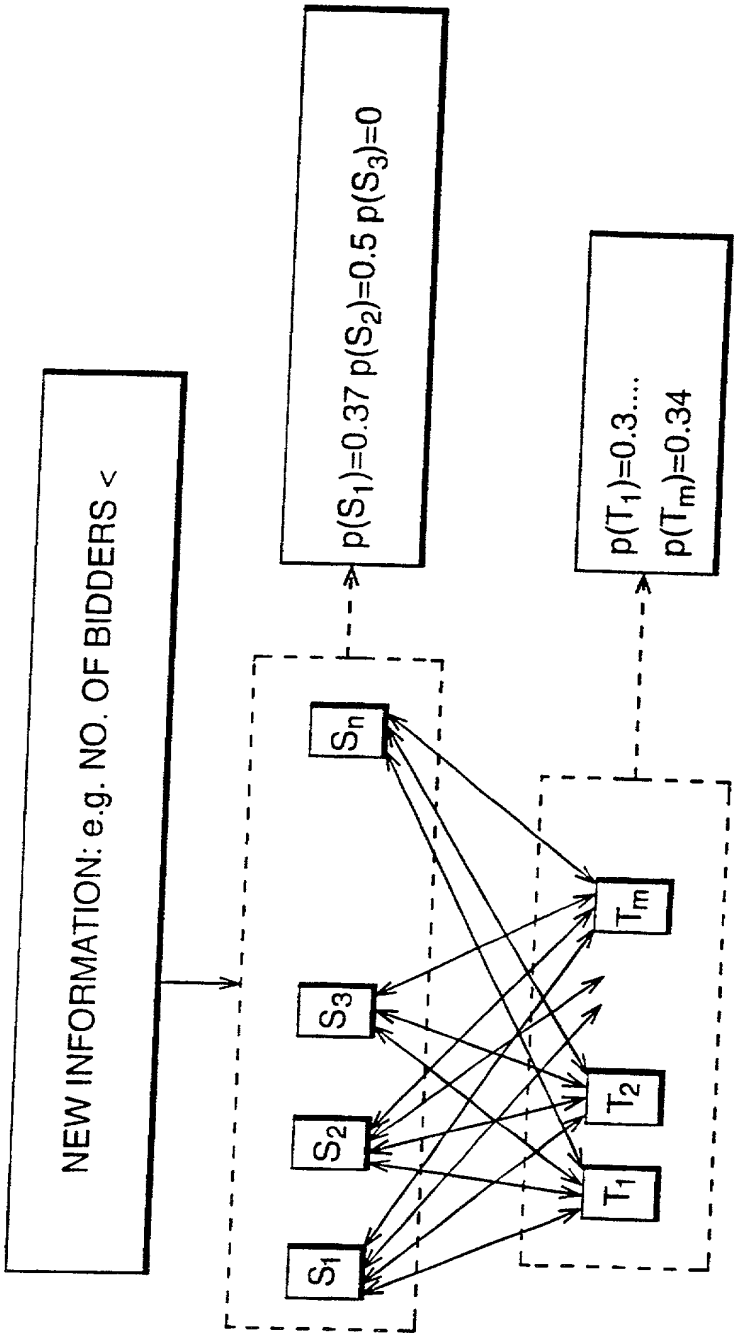


FIG. 5(e)

STAGE 4: DATA OF OBSERVED BEHAVIOUR IS USED TO COMPARE WITH VALUES IN T

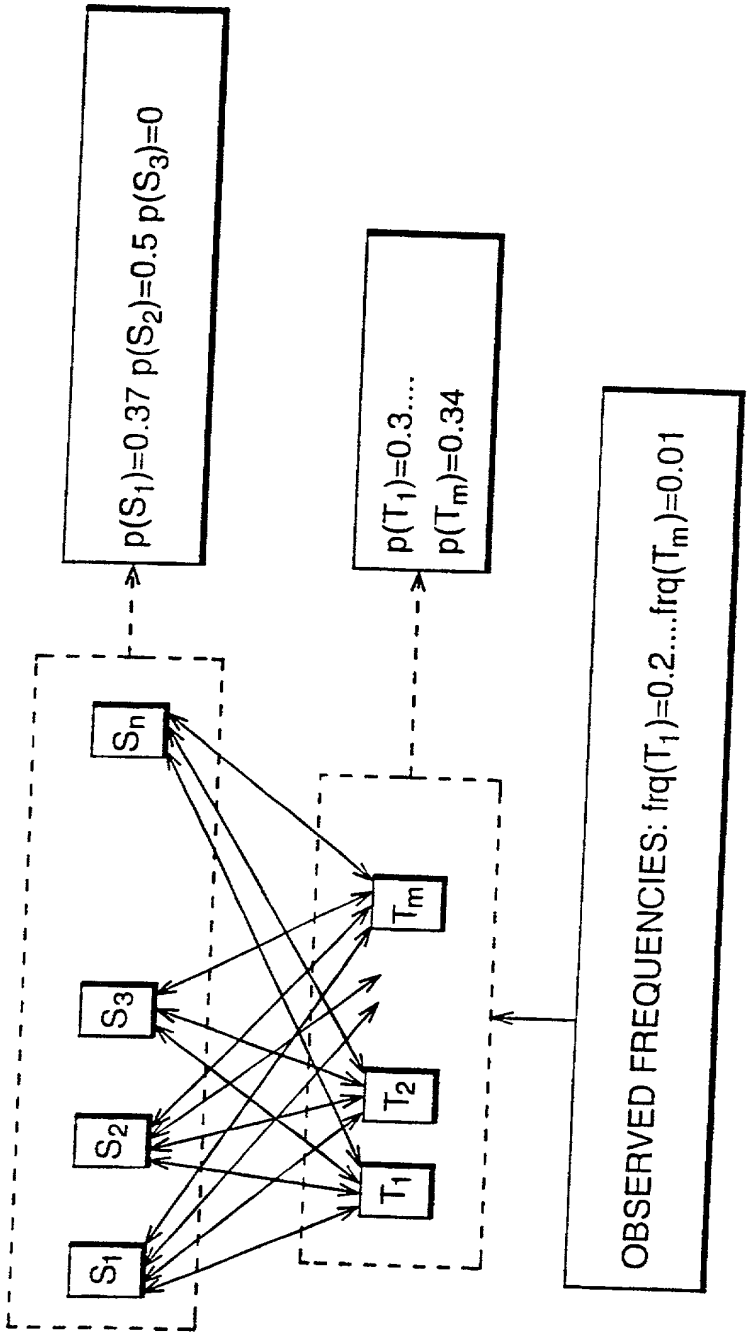
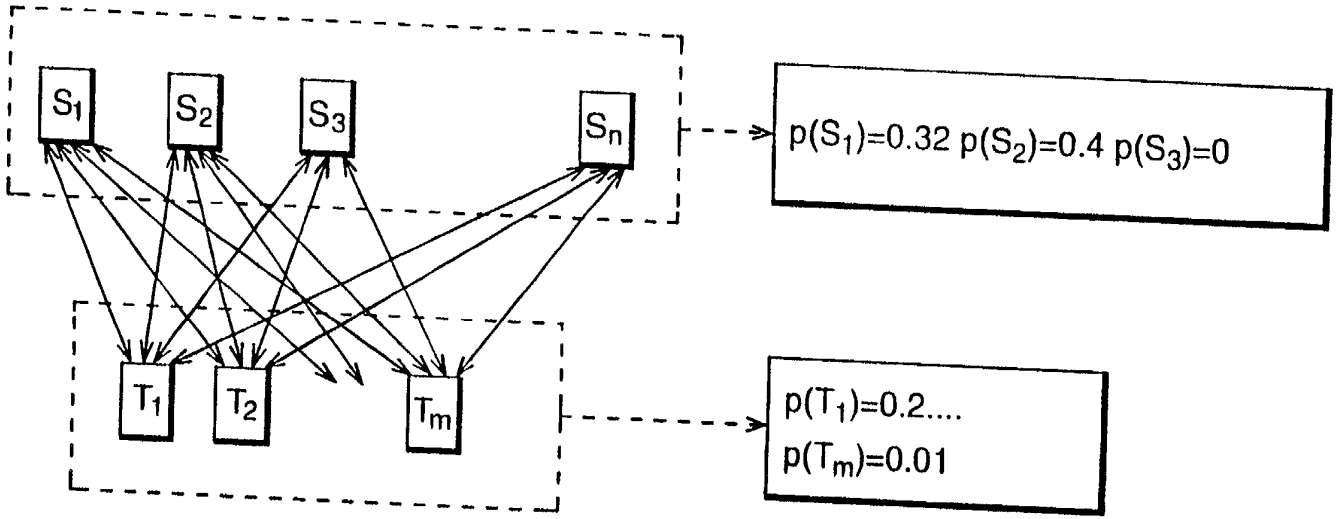


FIG. 5(f)

STAGE 5: INFORMATION REGARDING OBSERVED BEHAVIOUR IS USED FOR BACKWARDS UPDATING



STAGE 6: SYSTEM DETECTS INCONSISTENCY: "ERROR. AN ATTEMPT TO DIVIDE BY ZERO.
CAUSE: BACKWARD UPDATED VALUE OF S_3 IS GREATER THAN ZERO"

STAGE 7: SYSTEM REPORTS TO PROTOCOL: "MISMATCH BETWEEN CURRENT INFORMATION AND OBSERVED BEHAVIOUR.
POTENTIAL CAUSE: PRESENCE OF BIG PLAYERS".

FIG. 6

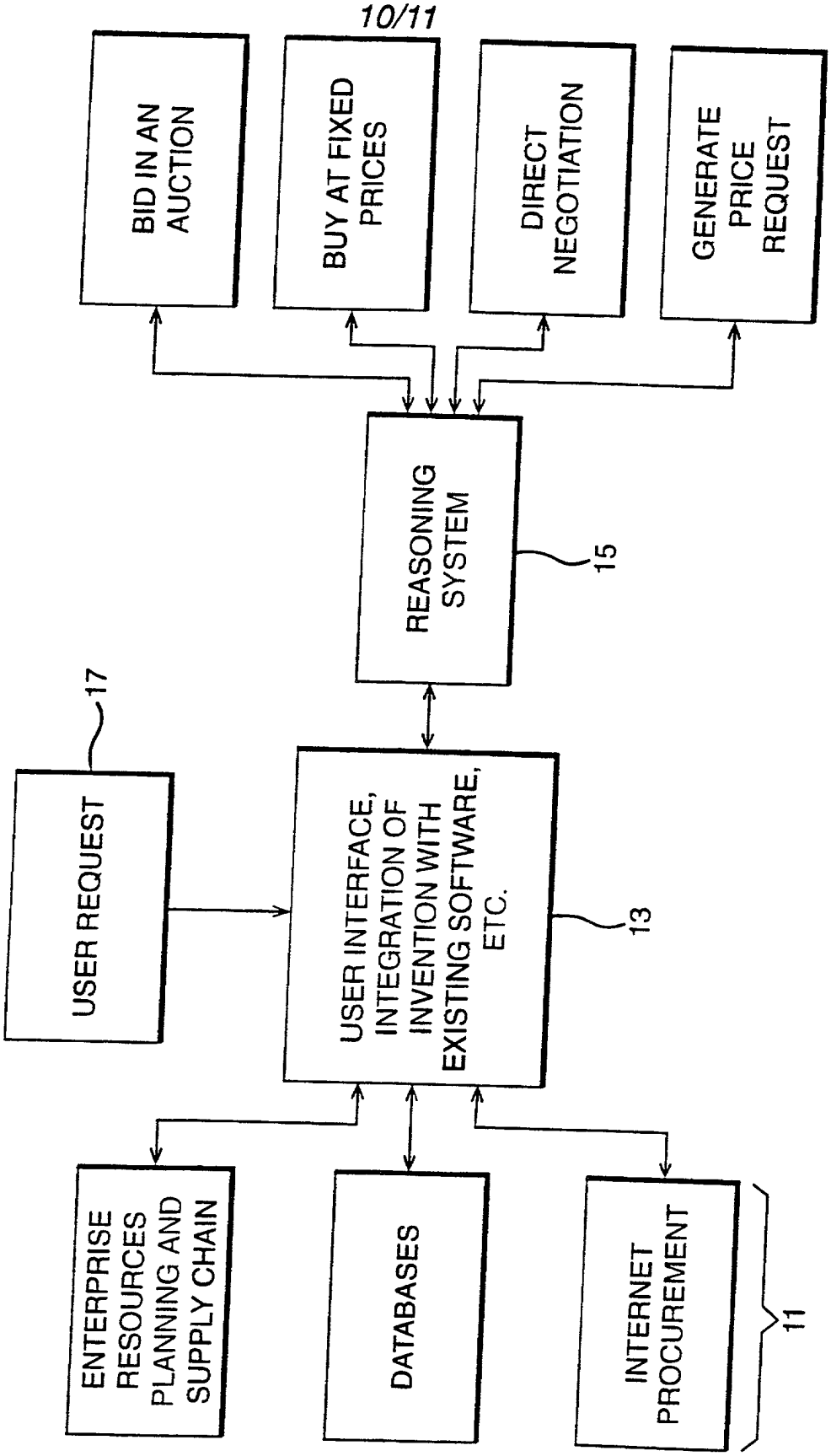
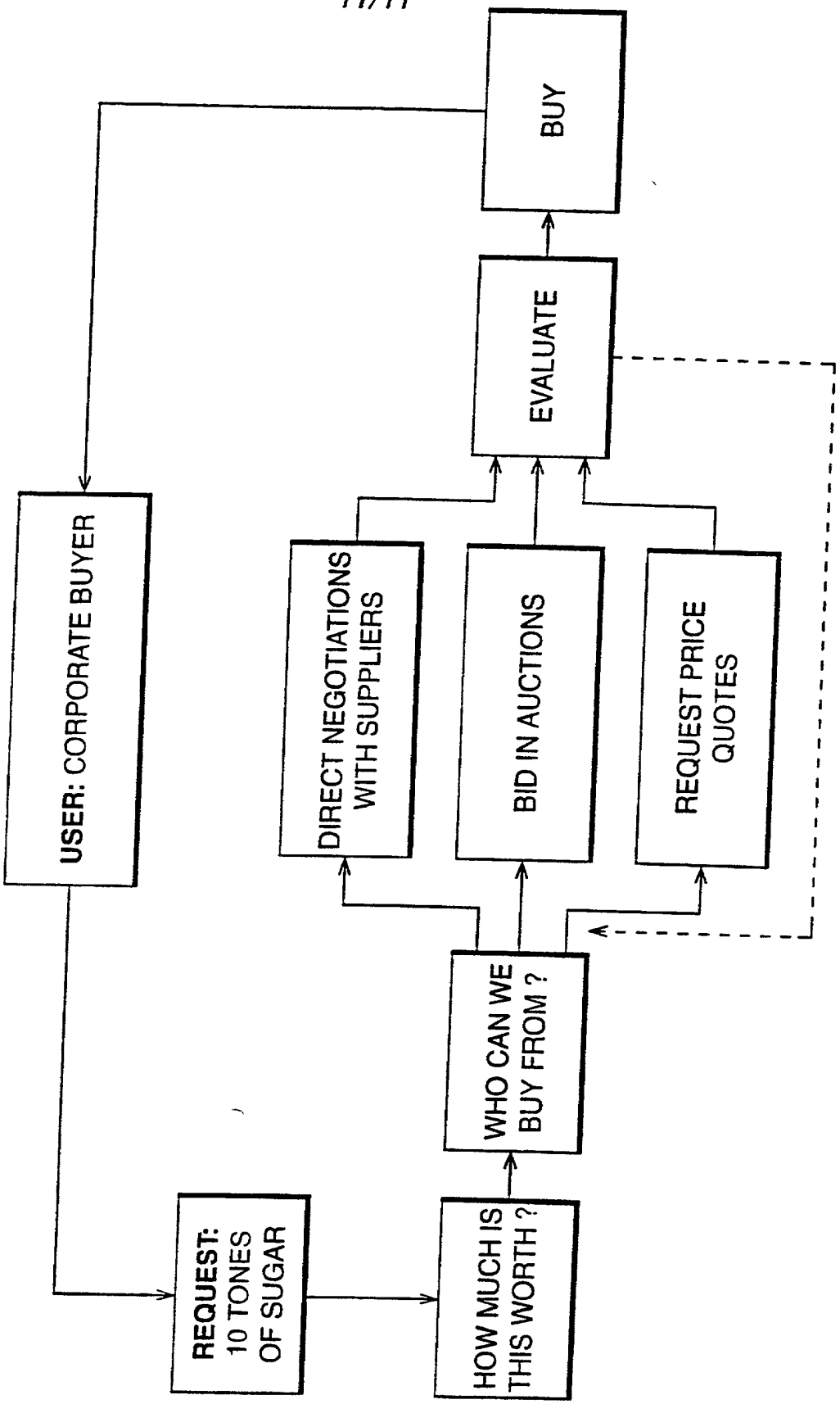

BID IN AN AUCTION
BUY AT FIXED PRICES
DIRECT NEGOTIATION
GENERATE PRICE REQUEST
REASONING SYSTEM
15
17
USER REQUEST
USER INTERFACE, INTEGRATION OF INVENTION WITH EXISTING SOFTWARE, ETC.
13
ENTERPRISE RESOURCES PLANNING AND SUPPLY CHAIN
DATABASES
INTERNET PROCUREMENT
11

FIG. 7


BUY
EVALUATE
USER: CORPORATE BUYER
DIRECT NEGOTIATIONS WITH SUPPLIERS
BID IN AUCTIONS
REQUEST PRICE QUOTES
WHO CAN WE BUY FROM ?
REQUEST: 10 TONES OF SUGAR
HOW MUCH IS THIS WORTH ?

Docket No.
P07179US00

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

the specification of which

(check one)

☐ is attached hereto:

☒ was filed on 25 October 1999 as United States Application No. or PCT International Application Number PCT/GB99/03528

and was amended on

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
9823321.6	GB	23 October 1998	☐
(Number)	(Country)	(Day/Month/Year Filed)	
			☐
(Number)	(Country)	(Day/Month/Year Filed)	
			☐
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below::

(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112. I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the practitioners of
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UNITED STATES OF AMERICA
Customer Number: 000881

agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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Sole or first inventor's	Date
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Full name of sole or first inventor	
Sole or first inventor's	Date
Residence	
Citizenship	
Post Office Address	

Full name of sole or first inventor	
Sole or first inventor's	Date
Residence	
Citizenship	
Post Office Address	